

(12) UK Patent Application (19) GB (11) 2 431 181 (13) A

(43) Date of A Publication 18.04.2007

(21) Application No: 0620188.3
(22) Date of Filing: 11.10.2006
(30) Priority Data:
(31) 11249967 (32) 13.10.2005 (33) US

(71) Applicant(s):
Enventure Global Technology
(Incorporated in USA - Delaware)
Suite 350, 15995 North Barkers Landing,
Houston, Texas 77079,
United States of America

(72) Inventor(s):
Gregory Marshall Noel

(74) Agent and/or Address for Service:
Haseltine Lake
Lincoln House, 300 High Holborn, London,
WC1V 7JH, United Kingdom

(51) INT CL:
E21B 43/10 (2006.01) E21B 17/08 (2006.01)

(52) UK CL (Edition X):
E1F FAC FAC9 FLA

(56) Documents Cited:
GB 2404677 A GB 2396635 A
WO 2002/095178 A1 WO 2002/028560 A2
WO 2001/018353 A1 WO 2000/066877 A1
US 20030227170 A1

(58) Field of Search:
UK CL (Edition X) E1F
INT CL E21B
Other: Online: WPI, EPODOC

(54) Abstract Title: Expandable tubular with sealing member

(57) An expandable tubular 600 comprises a first section 602, a second section 614 and an intermediate section 608. The outer diameters of the first and second sections are larger than that of the intermediate section. The tubular also includes either a seal 606 on the exterior of the first section, a seal 612 on the exterior of the intermediate section, or circumferentially spaced ribs (1208, fig 17) on the intermediate section. The ribs may comprise a seal. The seal may be formed from an elastomer, metal or a combination. Also disclosed is an expansion device for expanding a tubular, a method of fabricating an expandable tubular, and a method of coupling a tubular member to an existing tubular member.

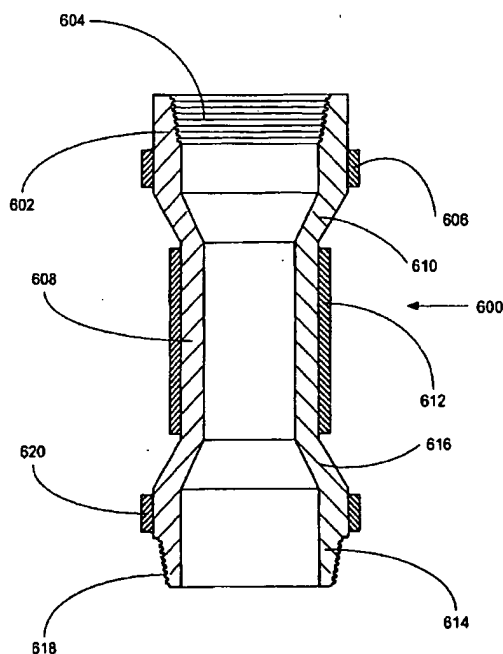


FIGURE 6

GB 2 431 181 A

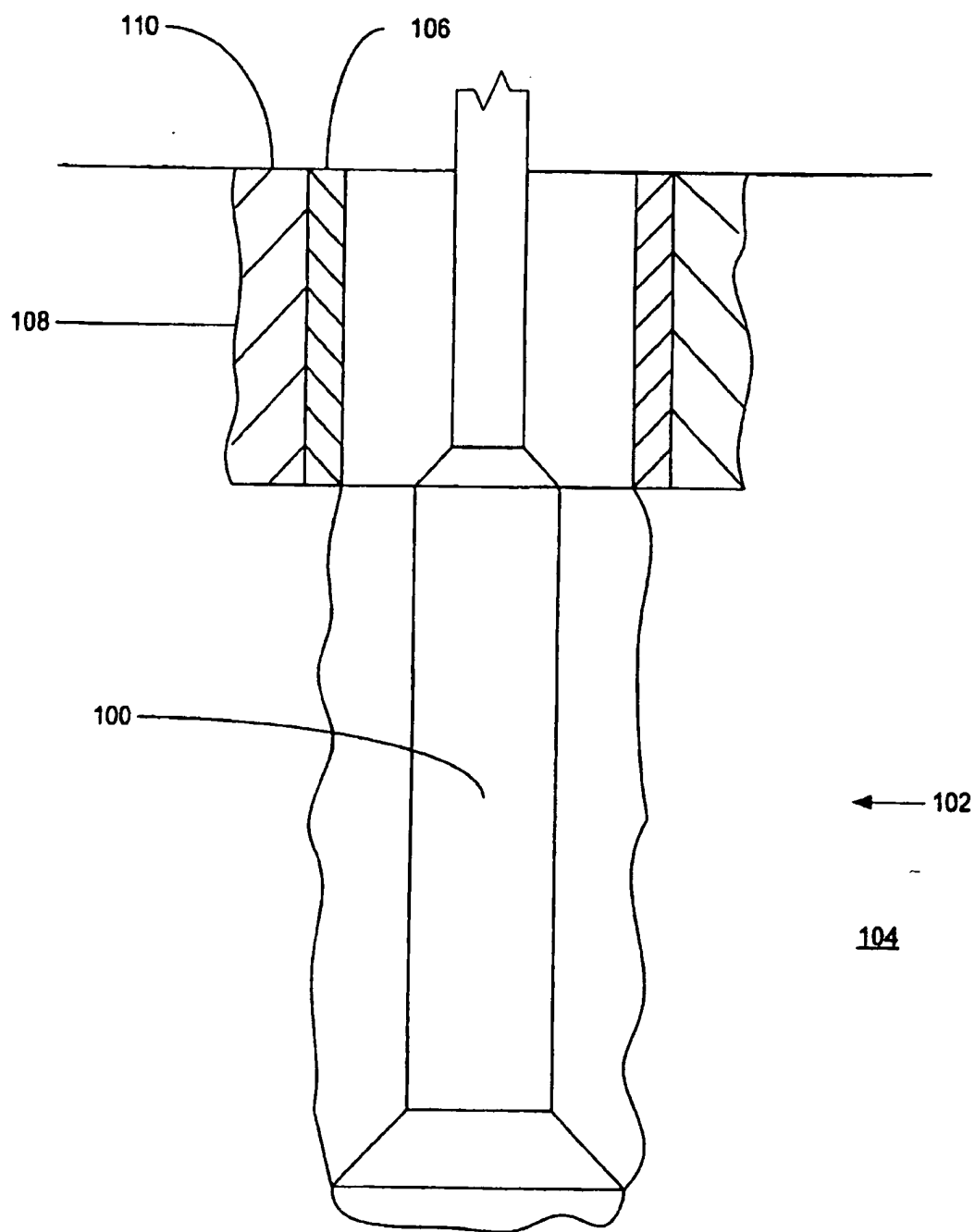
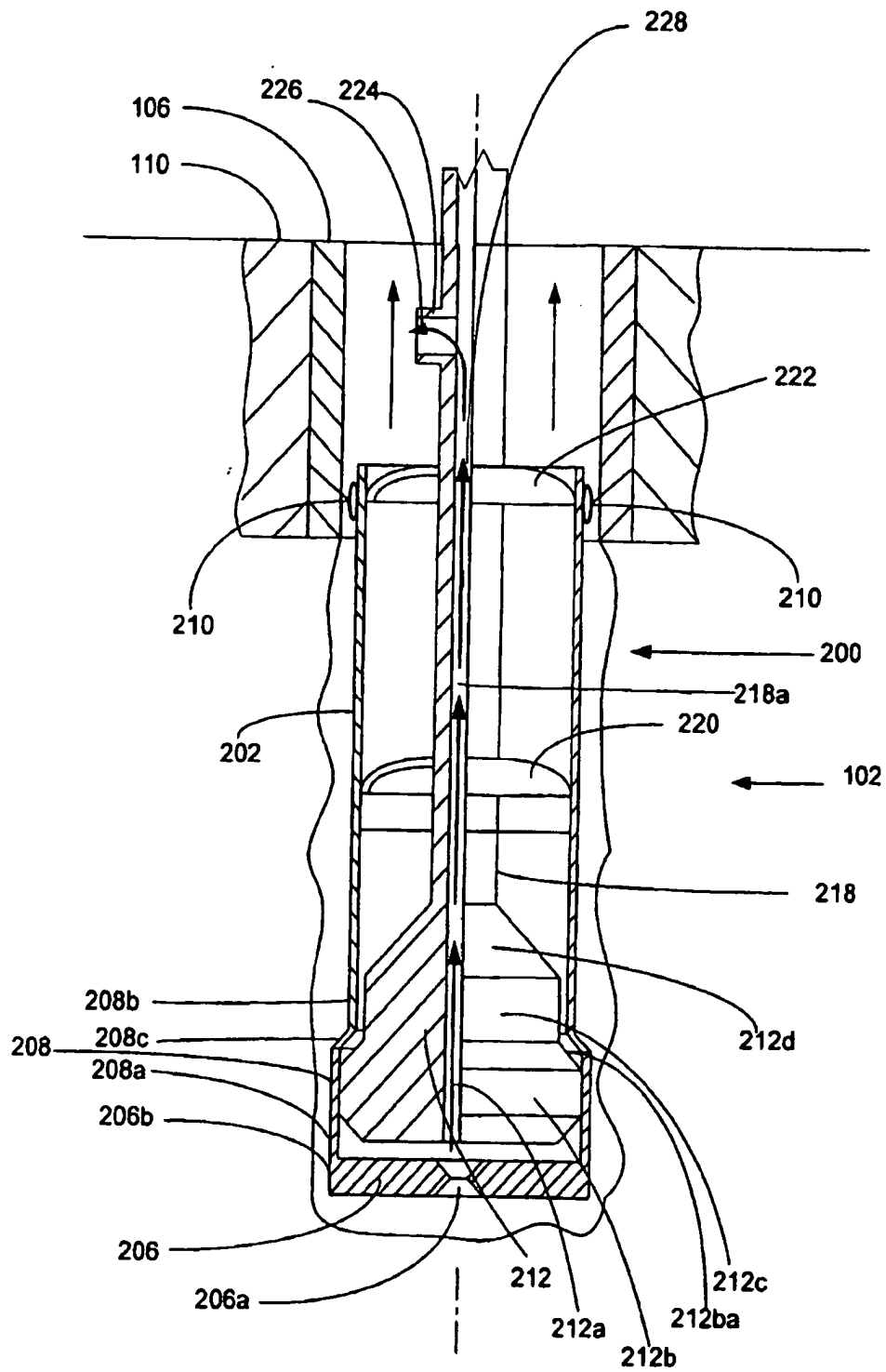


FIGURE 1



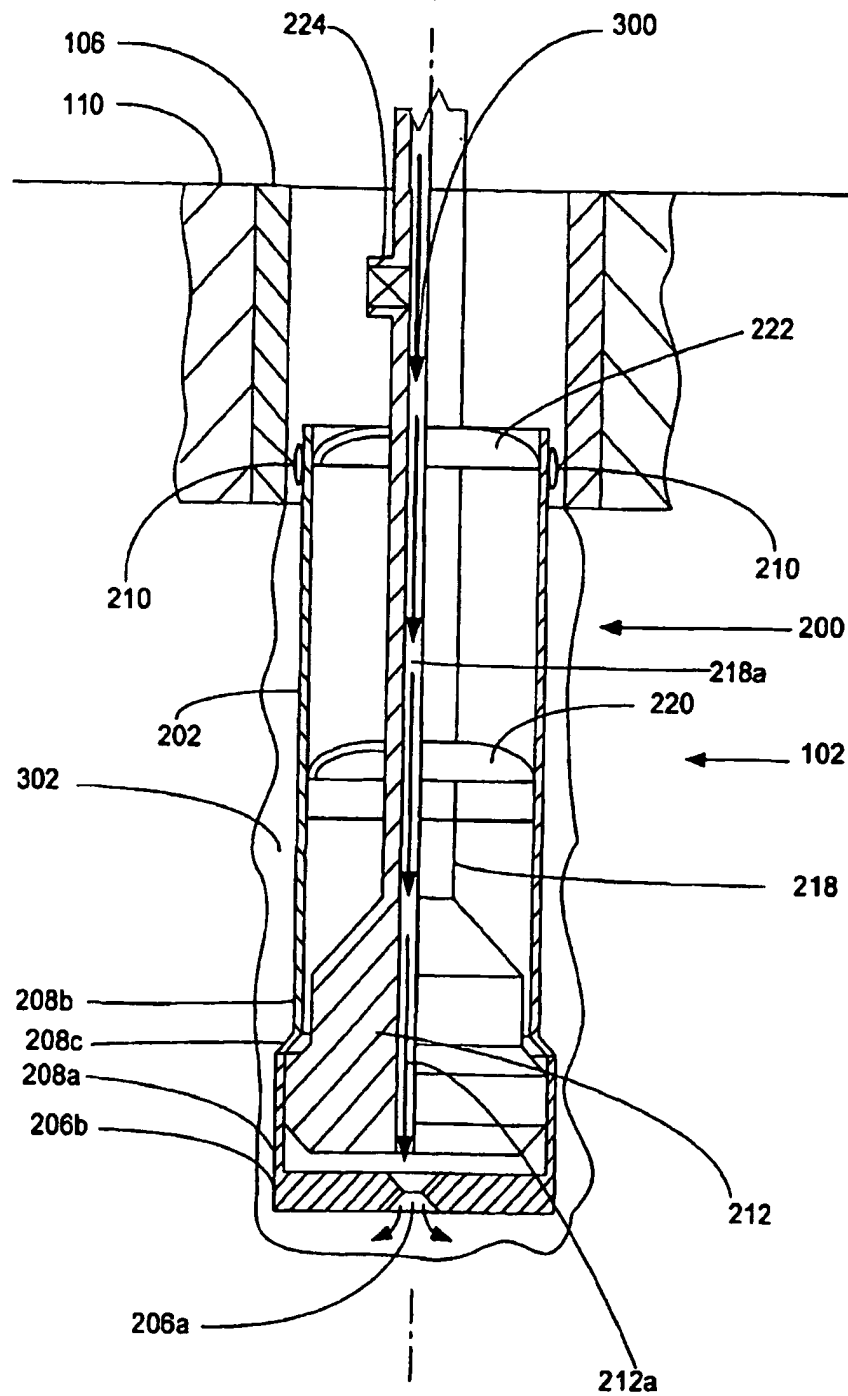


FIGURE 3

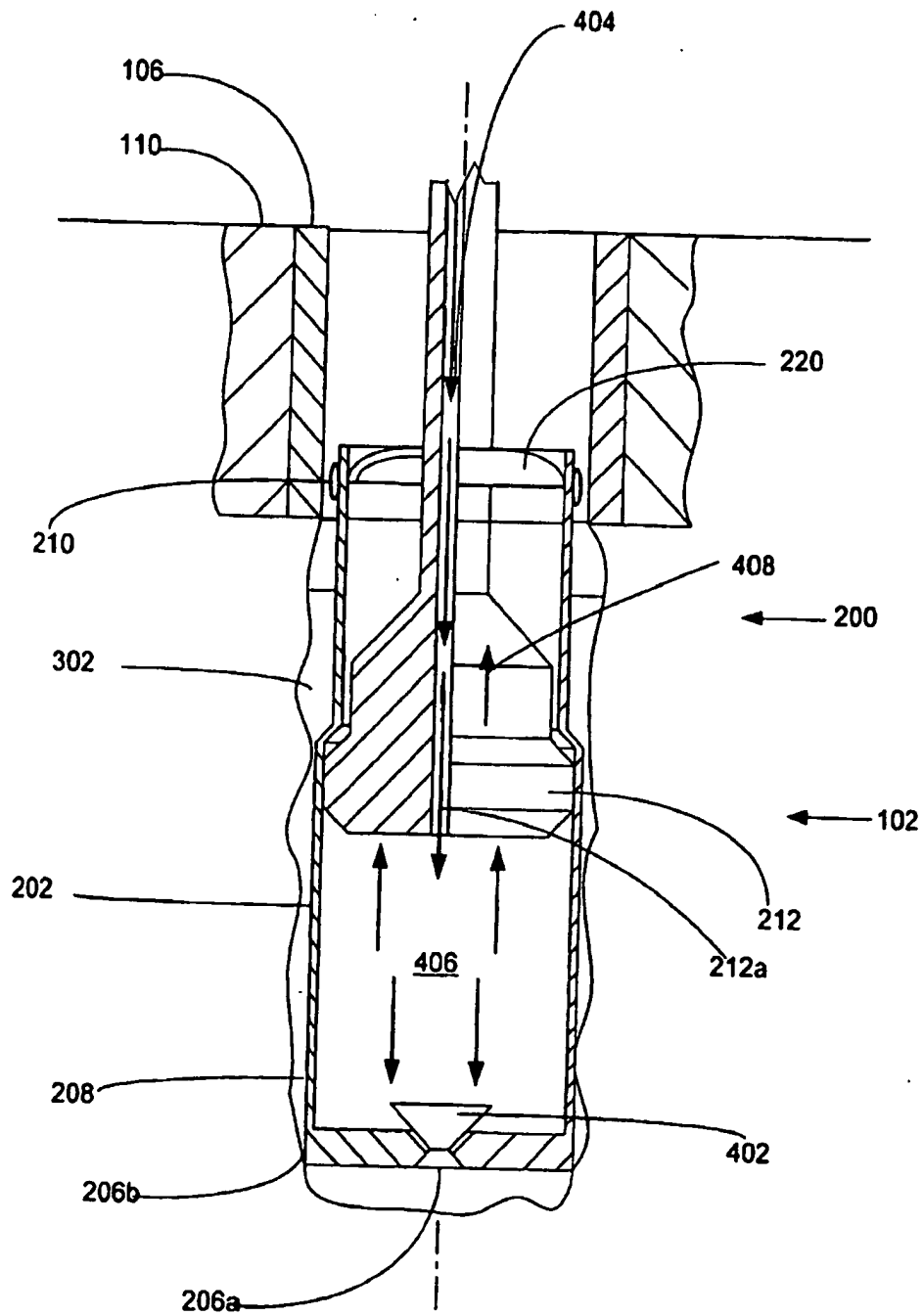


FIGURE 4

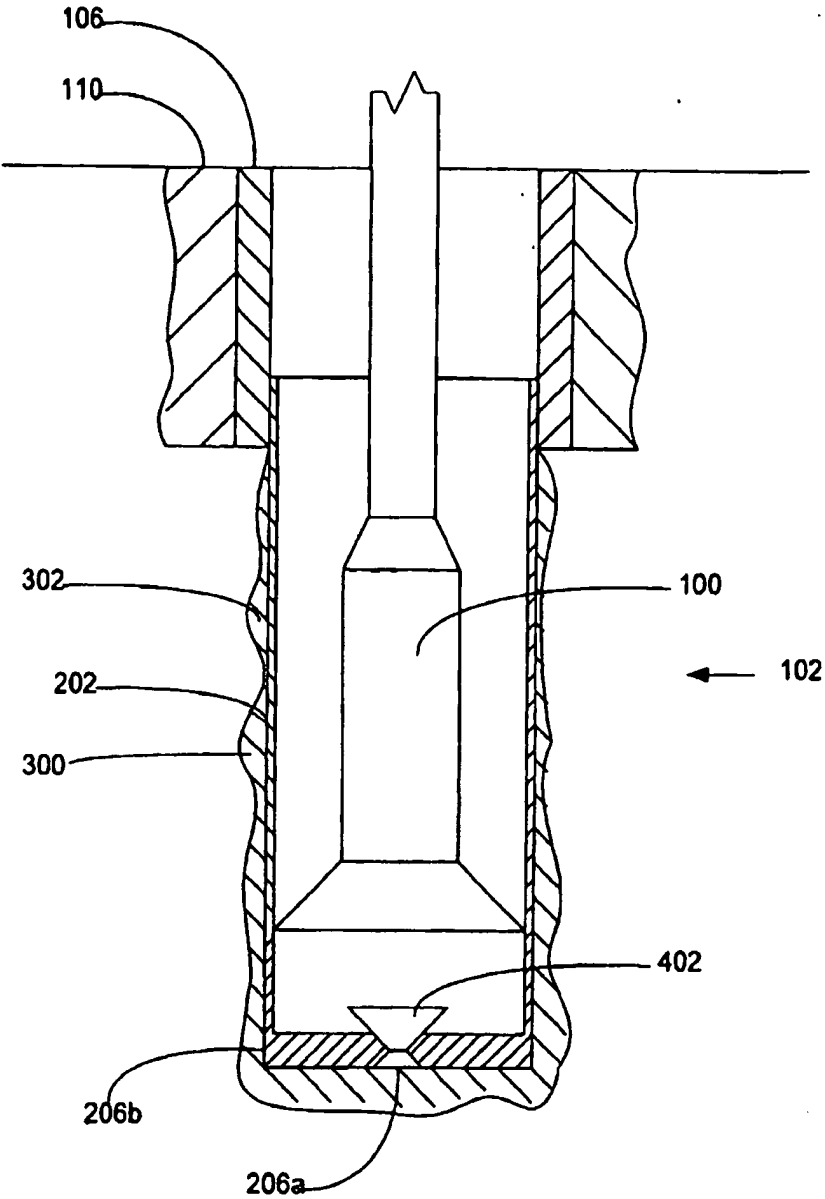


FIGURE 5

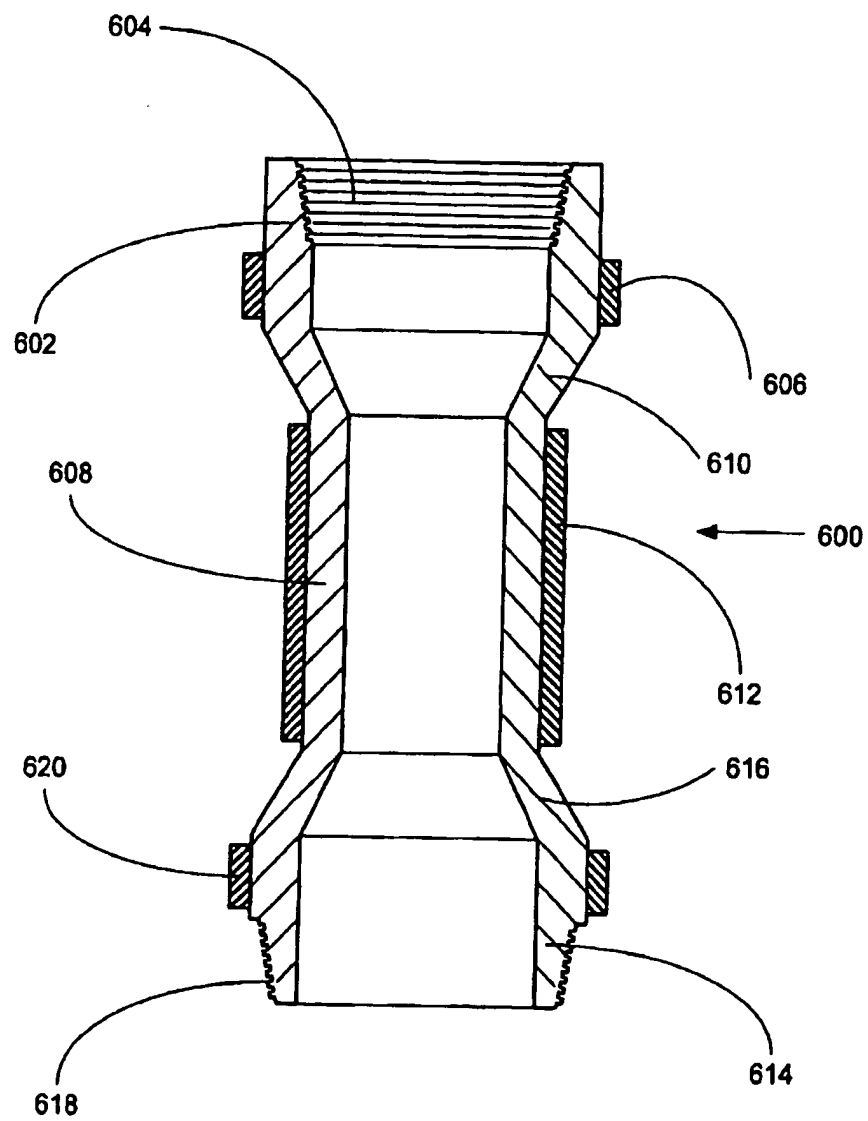


FIGURE 6

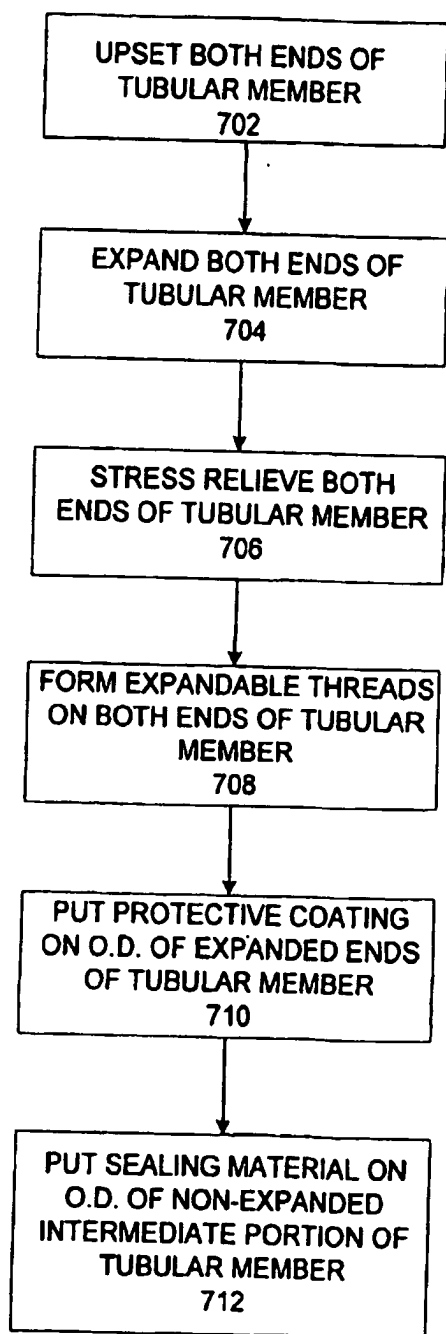


FIGURE 7

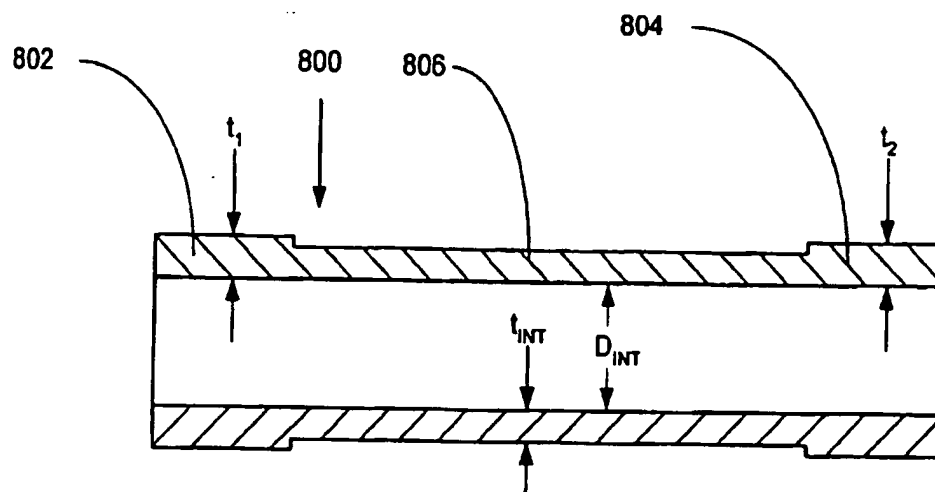


FIGURE 8

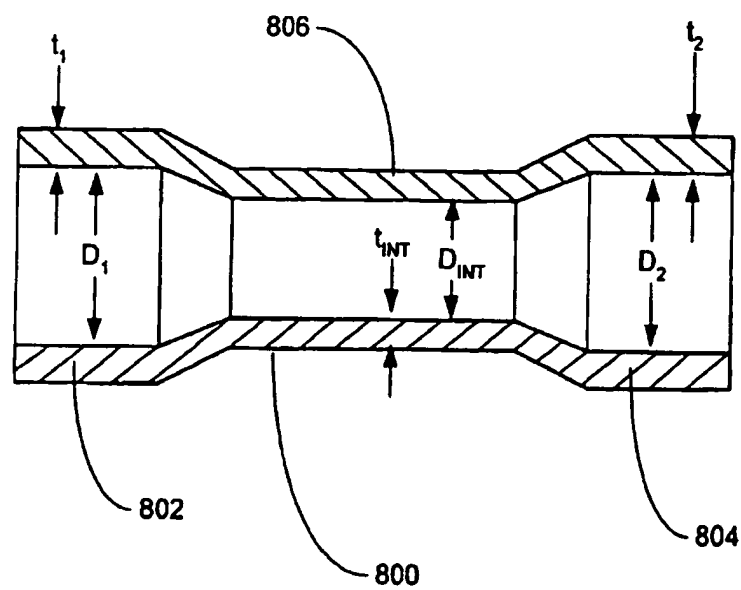


FIGURE 9

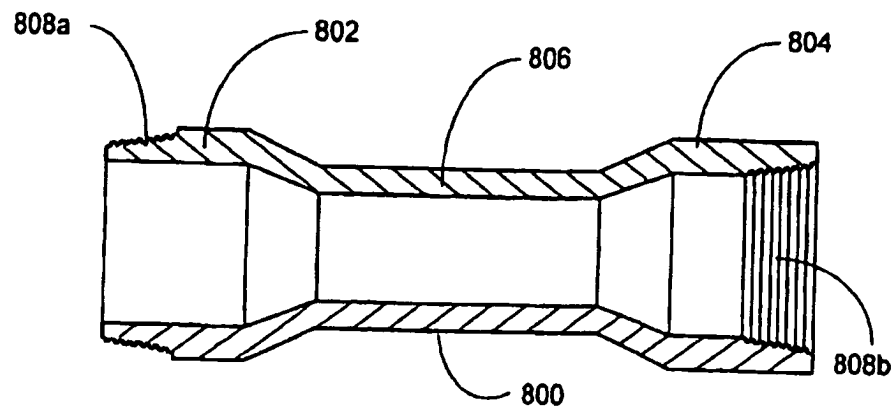


FIGURE 10

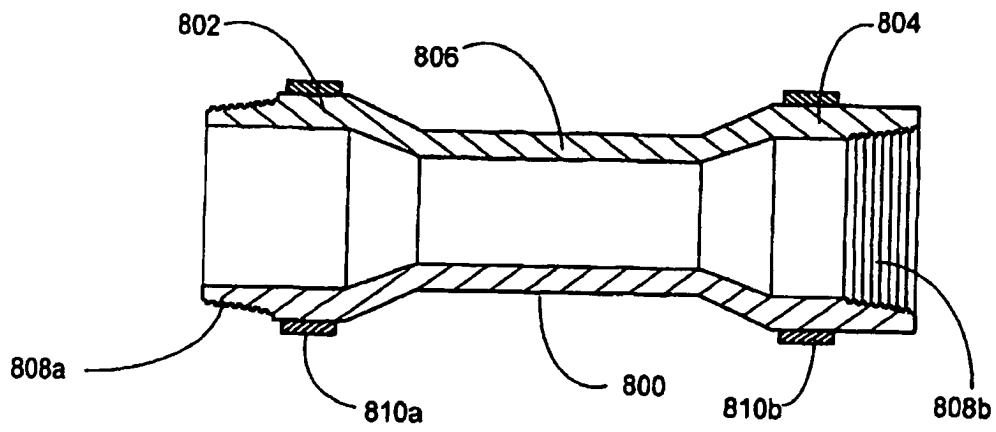


FIGURE 11

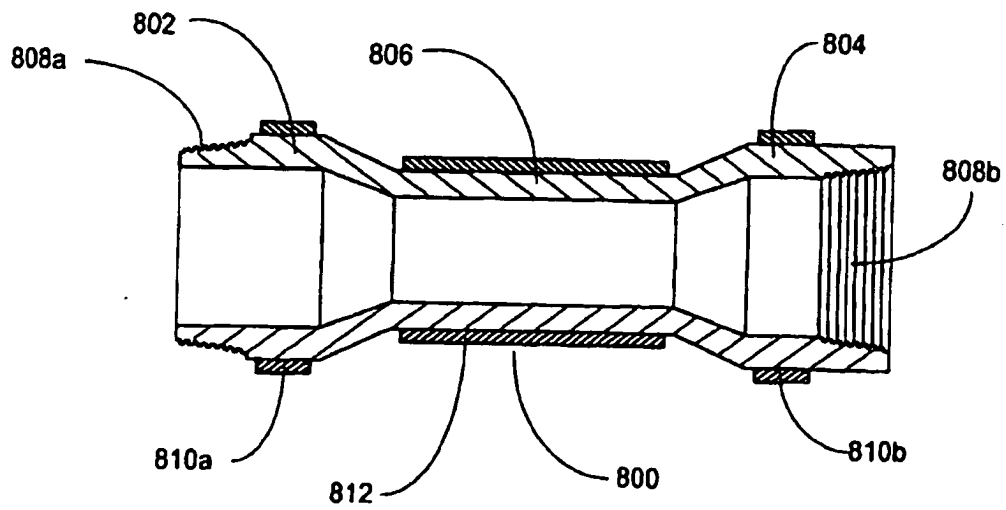
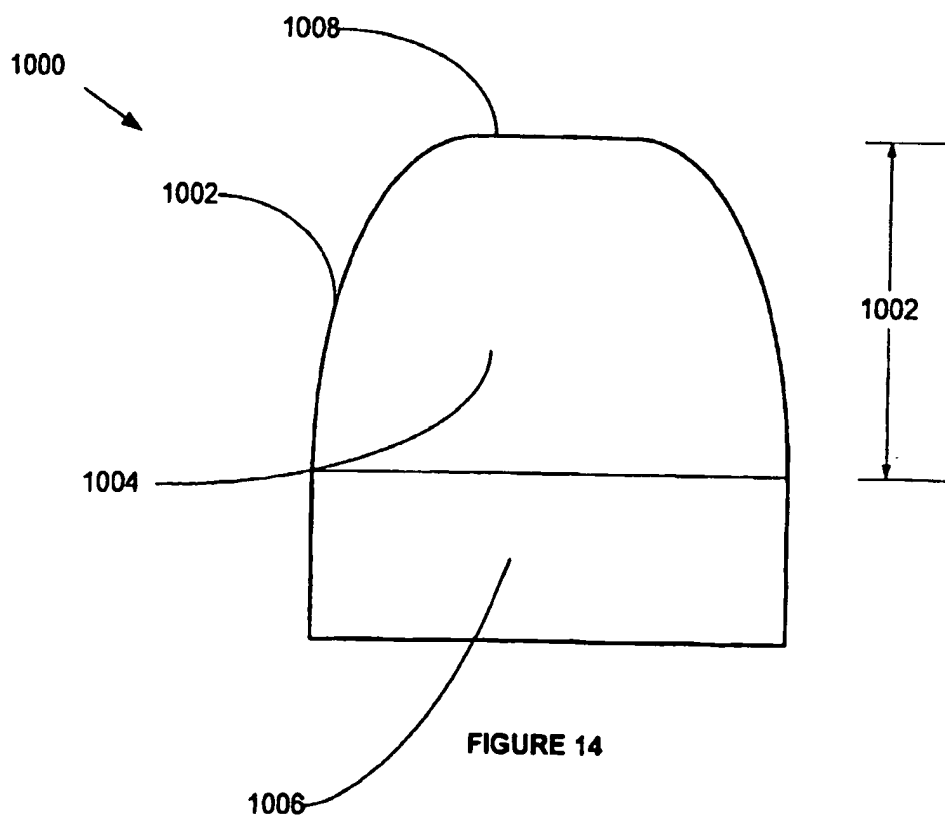
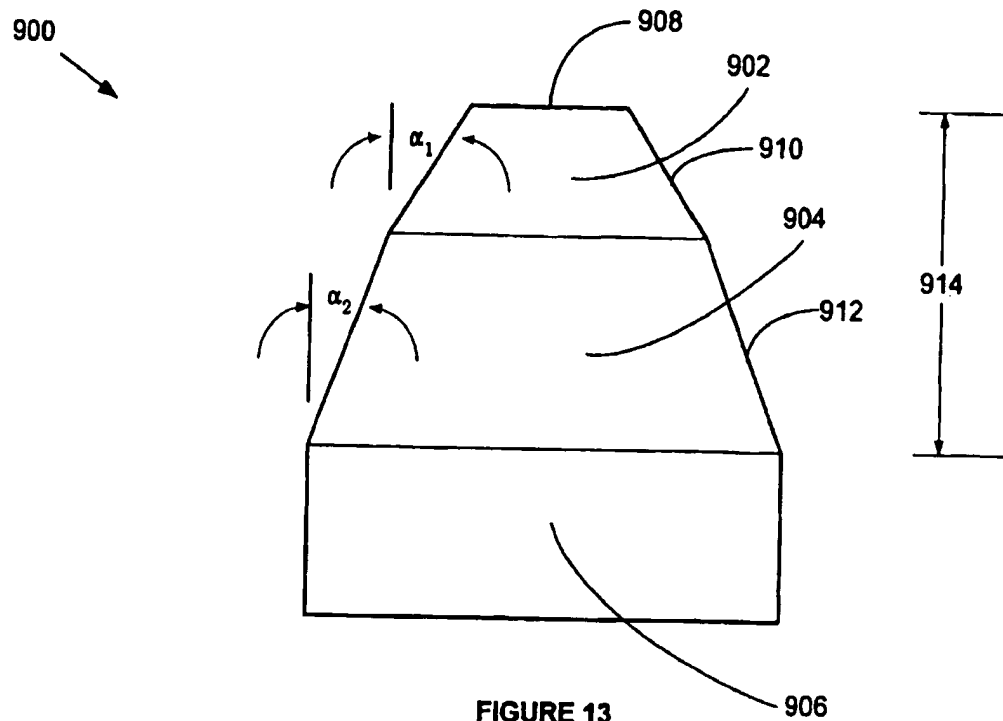
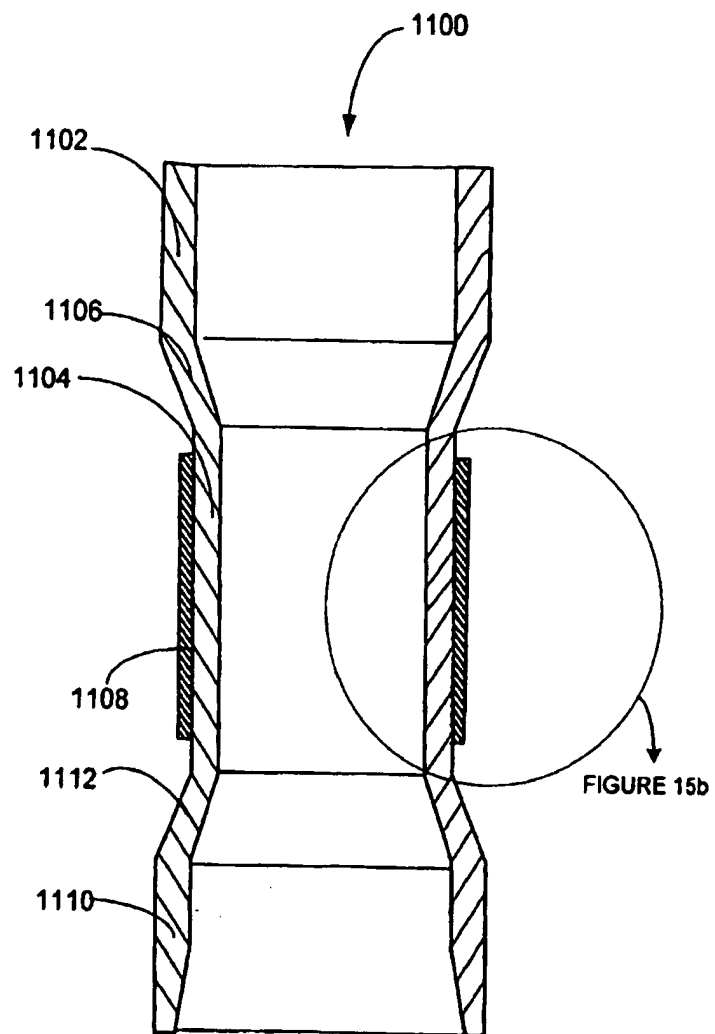


FIGURE 12





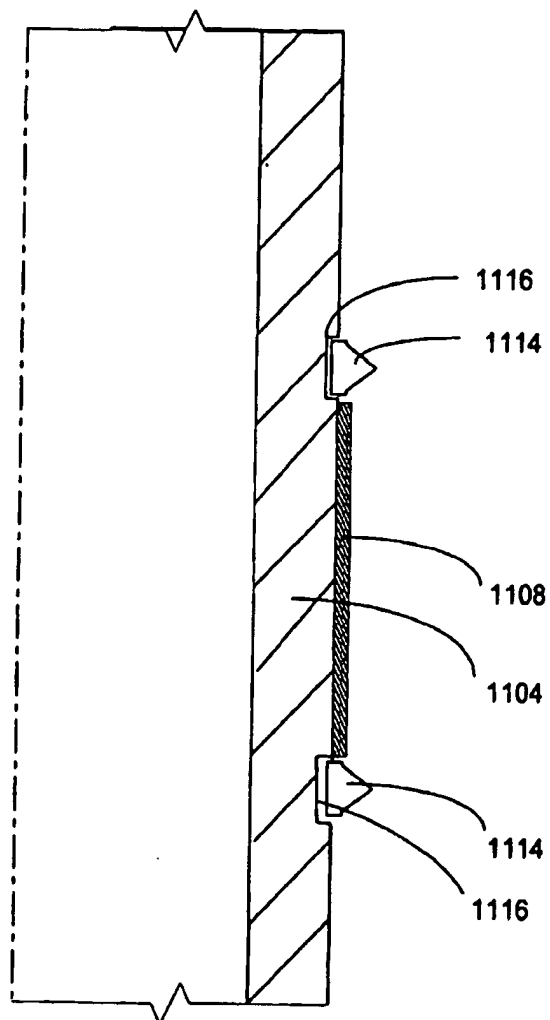


FIGURE 15b

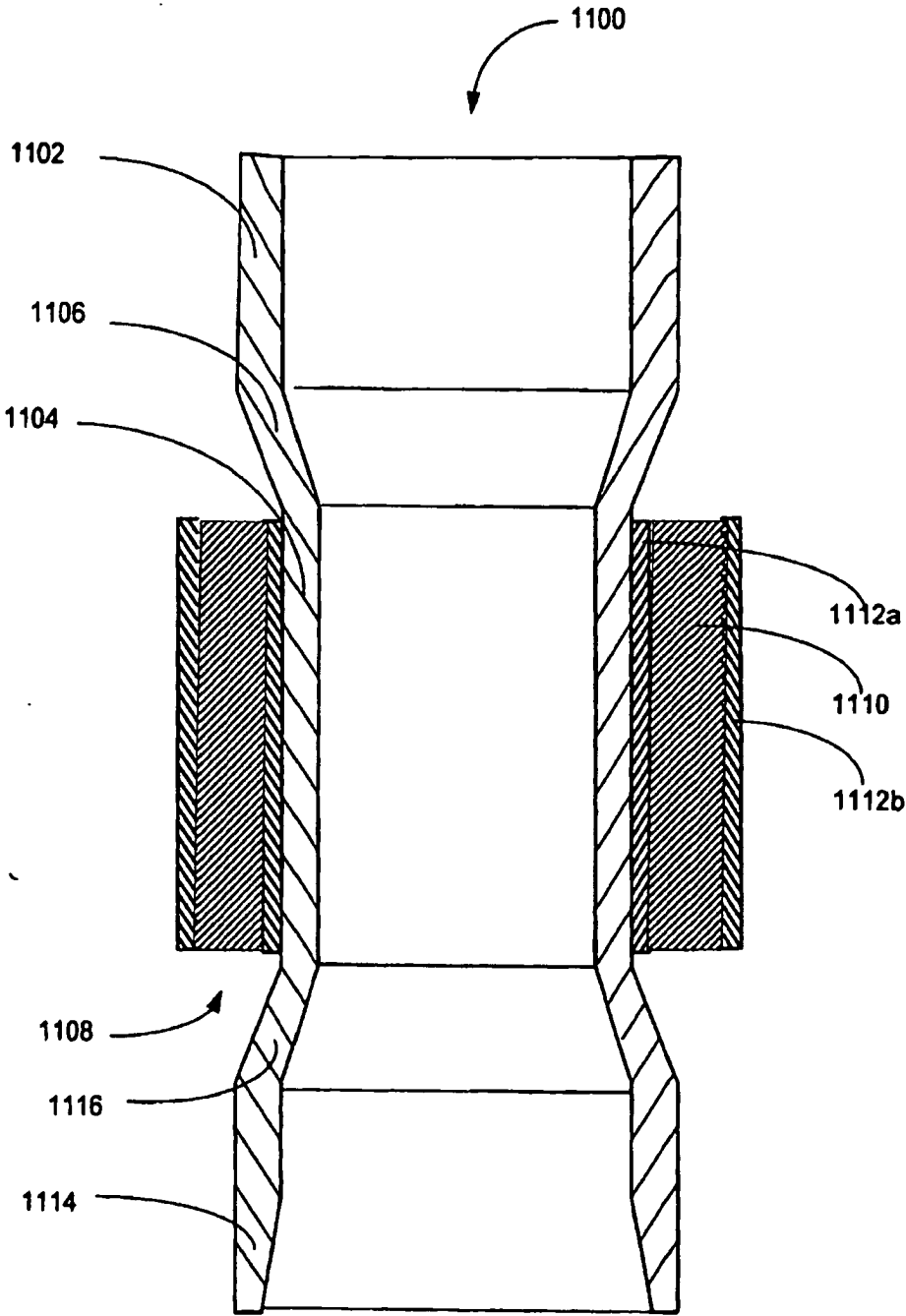


FIGURE 15c

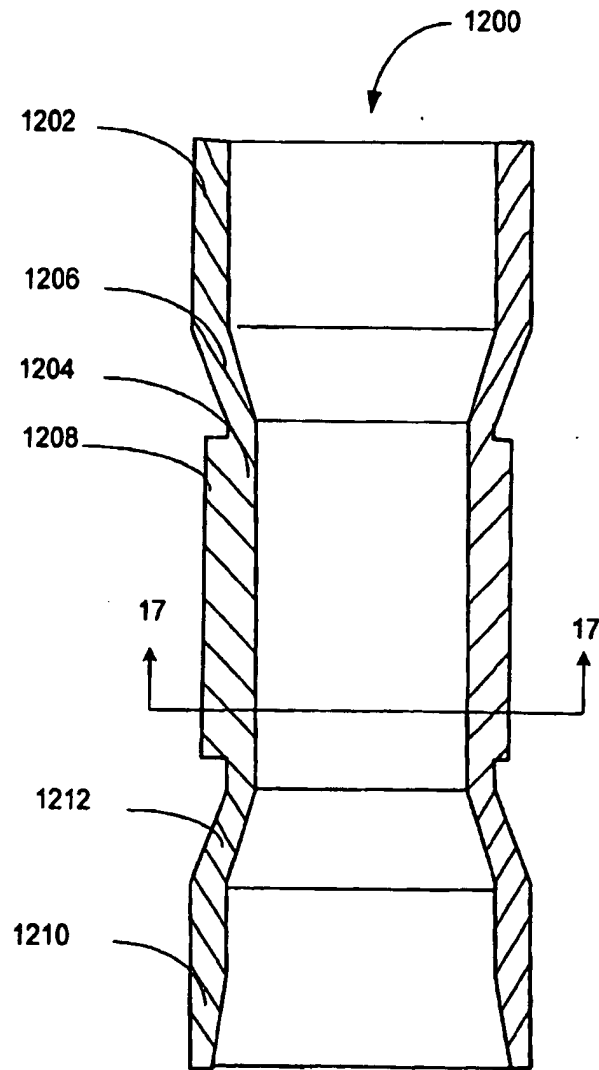


FIGURE 16

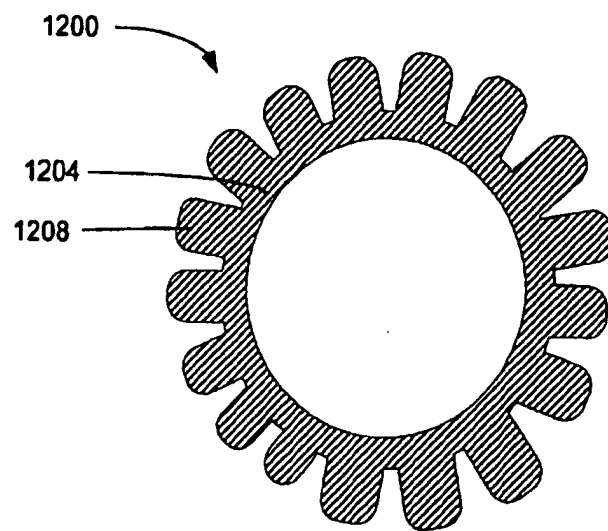


FIGURE 17

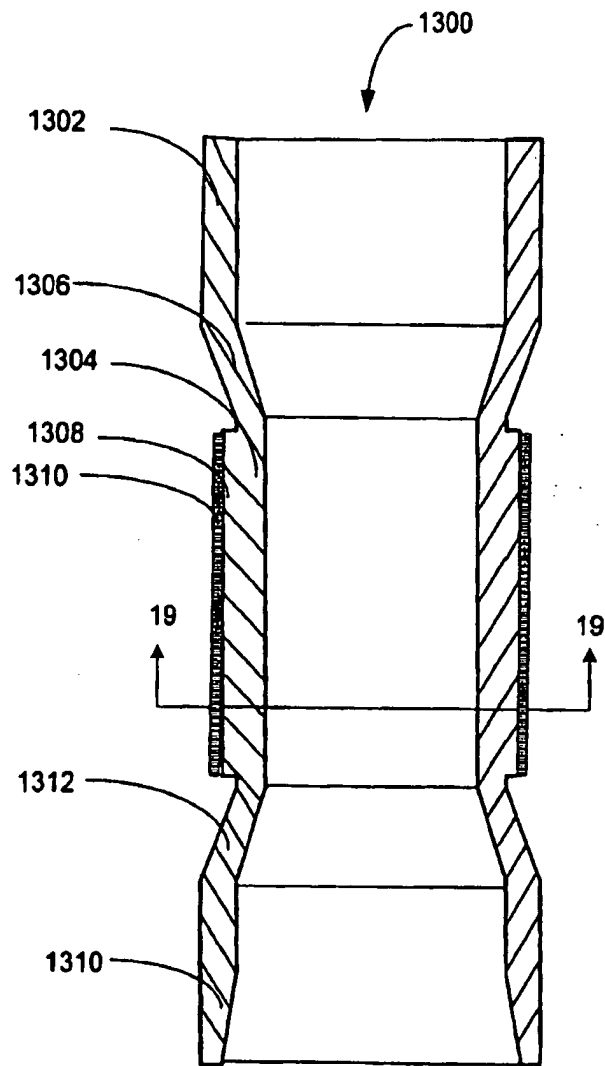


FIGURE 18

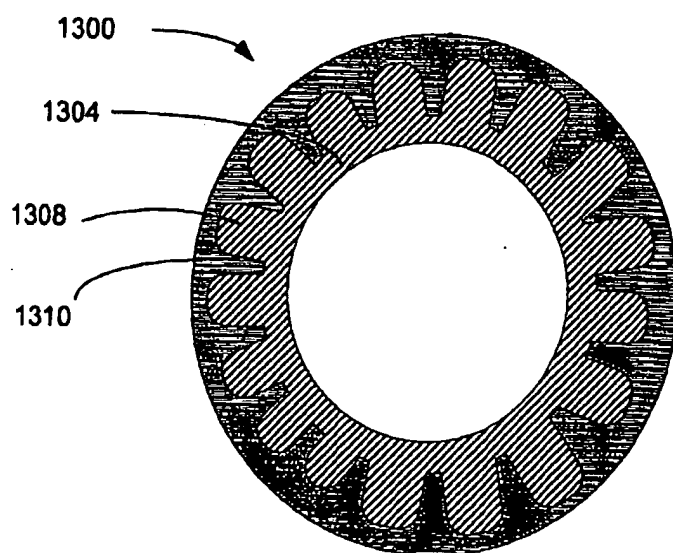


FIGURE 19

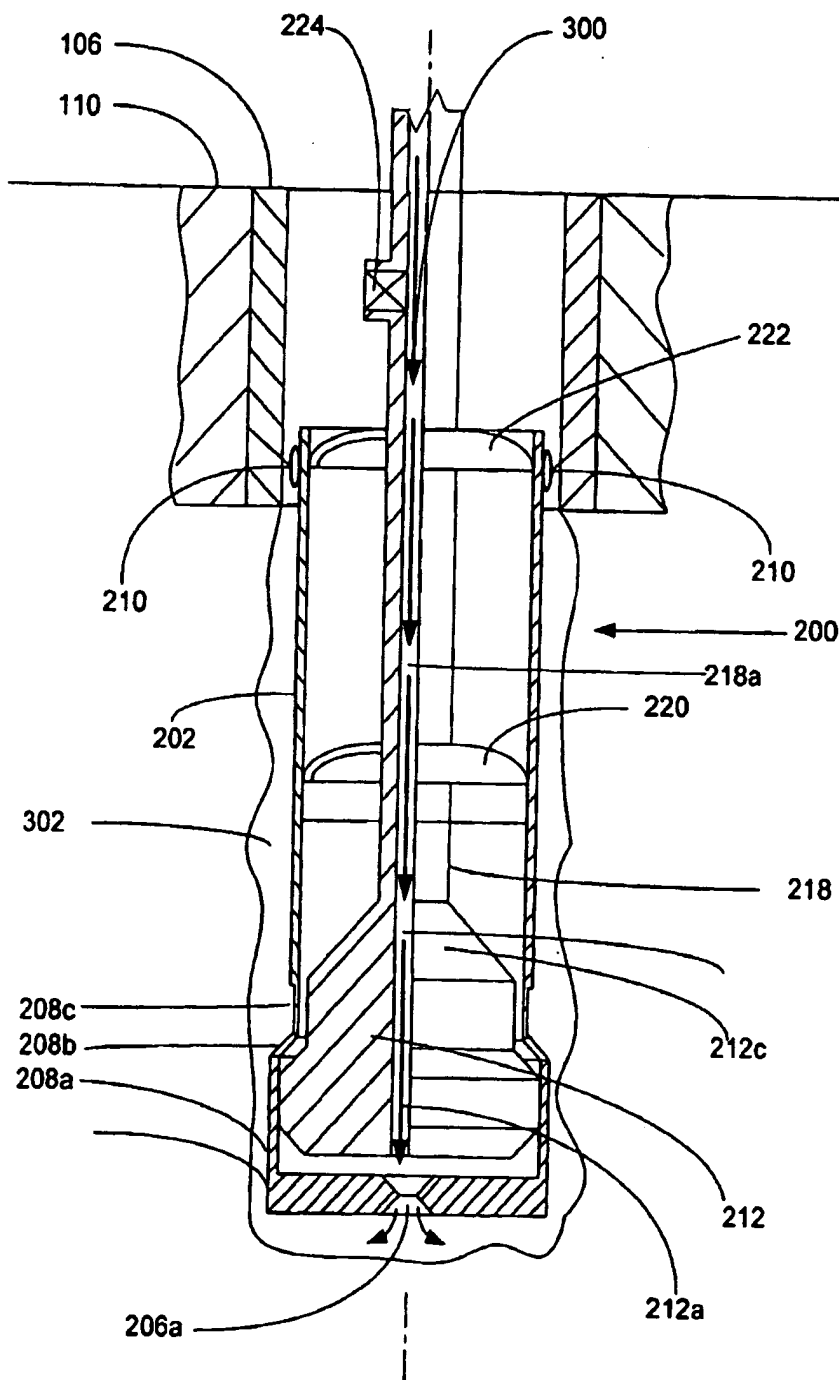


FIGURE 20

ANCHOR HANGERS**CROSS REFERENCE TO RELATED APPLICATIONS**

[0001] This application is a continuation-in-part of U.S. patent application serial number 10/030,593, attorney docket number 25791.25.08, filed on 1/8/2002, which was the National Stage for PCT application serial number PCT/US00/18635, attorney docket number 25791.25.02, filed on 7/7/2000, which claimed the benefit of U.S. provisional patent application serial number 60/137,998, filed on 6/7/1999, which was a continuation-in-part of U.S. patent application serial number 09/588,946, attorney docket number 25791.17.02, filed on 6/7/2000, which claimed the benefit of U.S. provisional patent application serial number 60/137,998, filed on 6/7/1999, which was a continuation-in-part of U.S. patent application serial number 09/559,122, attorney docket number 25791.23.02, filed on 4/26/2000, which claimed the benefit of U.S. provisional patent application serial number 60/131,106, filed on 4/26/1999, which was a continuation-in-part of U.S. patent application serial number 09/523,460, attorney docket number 25791.11.02, which claimed the benefit of the filing date of U.S. provisional patent application serial number 60/124,042, filed on 3/11/1999, which was a continuation-in-part of U.S. patent application serial number 09/510,913, attorney docket number 25791.7.02, which claimed the benefit of the filing date of U.S. provisional patent application serial number 60/121,702, filed on 2/25/1999, which was a continuation-in-part of U.S. patent application serial number 09/502,350, attorney docket number 25791.8.02, filed on February 10, 2000, which claimed the benefit of the filing date of U.S. provisional patent application serial number 60/119,611, attorney docket number 25791.8, filed on 2/11/1999, which was a continuation-in-part of U.S. patent application serial number 09/454,139, attorney docket number 25791.3.02, filed on 12/3/1999, which claimed the benefit of the filing date of U.S. provisional patent application serial number 60/111,293, filed on 12/7/1998.

[0002] This application is related to the following co-pending applications: (1) U.S. Patent Number 6,497,289, which was filed as U.S. Patent Application serial no. 09/454,139, attorney docket no. 25791.03.02, filed on 12/3/1999, which claims priority from provisional application 60/111,293, filed on 12/7/98, (2) U.S. patent application serial no. 09/510,913, attorney docket no. 25791.7.02, filed on 2/23/2000, which claims

priority from provisional application 60/121,702, filed on 2/25/99, (3) U.S. patent application serial no. 09/502,350, attorney docket no. 25791.8.02, filed on 2/10/2000, which claims priority from provisional application 60/119,611, filed on 2/11/99, (4) U.S. patent no. 6,328,113, which was filed as U.S. Patent Application serial number 09/440,338, attorney docket number 25791.9.02, filed on 11/15/99, which claims priority from provisional application 60/108,558, filed on 11/16/98, (5) U.S. patent application serial no. 10/169,434, attorney docket no. 25791.10.04, filed on 7/1/02, which claims priority from provisional application 60/183,546, filed on 2/18/00, (6) U.S. patent application serial no. 09/523,468, attorney docket no. 25791.11.02, filed on 3/10/2000, which claims priority from provisional application 60/124,042, filed on 3/11/99, (7) U.S. patent number 6,568,471, which was filed as patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, which claims priority from provisional application 60/121,841, filed on 2/26/99, (8) U.S. patent number 6,575,240, which was filed as patent application serial no. 09/511,941, attorney docket no. 25791.16.02, filed on 2/24/2000, which claims priority from provisional application 60/121,907, filed on 2/26/99, (9) U.S. patent number 6,557,640, which was filed as patent application serial no. 09/588,946, attorney docket no. 25791.17.02, filed on 6/7/2000, which claims priority from provisional application 60/137,998, filed on 6/7/99, (10) U.S. patent application serial no. 09/981,916, attorney docket no. 25791.18, filed on 10/18/01 as a continuation-in-part application of U.S. patent no. 6,328,113, which was filed as U.S. Patent Application serial number 09/440,338, attorney docket number 25791.9.02, filed on 11/15/99, which claims priority from provisional application 60/108,558, filed on 11/16/98, (11) U.S. patent number 6,604,763, which was filed as application serial no. 09/559,122, attorney docket no. 25791.23.02, filed on 4/26/2000, which claims priority from provisional application 60/131,106, filed on 4/26/99, (12) U.S. patent application serial no. 10/030,593, attorney docket no. 25791.25.08, filed on 1/8/02, which claims priority from provisional application 60/146,203, filed on 7/29/99, (13) U.S. provisional patent application serial no. 60/143,039, attorney docket no. 25791.26, filed on 7/9/99, (14) U.S. patent application serial no. 10/111,982, attorney docket no. 25791.27.08, filed on 4/30/02, which claims priority from provisional patent application serial no. 60/162,671, attorney docket no. 25791.27, filed on 11/1/1999, (15)

U.S. provisional patent application serial no. 60/154,047, attorney docket no. 25791.29, filed on 9/16/1999, (16) U.S. provisional patent application serial no. 60/438,828, attorney docket no. 25791.31, filed on 1/9/03, (17) U.S. patent number 6,564,875, which was filed as application serial no. 09/679,907, attorney docket no. 25791.34.02, on 10/5/00, which claims priority from provisional patent application serial no. 60/159,082, attorney docket no. 25791.34, filed on 10/12/1999, (18) U.S. patent application serial no. 10/089,419, filed on 3/27/02, attorney docket no. 25791.36.03, which claims priority from provisional patent application serial no. 60/159,039, attorney docket no. 25791.36, filed on 10/12/1999, (19) U.S. patent application serial no. 09/679,906, filed on 10/5/00, attorney docket no. 25791.37.02, which claims priority from provisional patent application serial no. 60/159,033, attorney docket no. 25791.37, filed on 10/12/1999, (20) U.S. patent application serial no. 10/303,992, filed on 11/22/02, attorney docket no. 25791.38.07, which claims priority from provisional patent application serial no. 60/212,359, attorney docket no. 25791.38, filed on 6/19/2000, (21) U.S. provisional patent application serial no. 60/165,228, attorney docket no. 25791.39, filed on 11/12/1999, (22) U.S. provisional patent application serial no. 60/455,051, attorney docket no. 25791.40, filed on 3/14/03, (23) PCT application US02/2477, filed on 6/26/02, attorney docket no. 25791.44.02, which claims priority from U.S. provisional patent application serial no. 60/303,711, attorney docket no. 25791.44, filed on 7/6/01, (24) U.S. patent application serial no. 10/311,412, filed on 12/12/02, attorney docket no. 25791.45.07, which claims priority from provisional patent application serial no. 60/221,443, attorney docket no. 25791.45, filed on 7/28/2000, (25) U.S. patent application serial no. 10/, filed on 12/18/02, attorney docket no. 25791.46.07, which claims priority from provisional patent application serial no. 60/221,645, attorney docket no. 25791.46, filed on 7/28/2000, (26) U.S. patent application serial no. 10/322,947, filed on 1/22/03, attorney docket no. 25791.47.03, which claims priority from provisional patent application serial no. 60/233,638, attorney docket no. 25791.47, filed on 9/18/2000, (27) U.S. patent application serial no. 10/406,648, filed on 3/31/03, attorney docket no. 25791.48.06, which claims priority from provisional patent application serial no. 60/237,334, attorney docket no. 25791.48, filed on 10/2/2000, (28) PCT application US02/04353, filed on 2/14/02, attorney docket no. 25791.50.02, which claims priority

from U.S. provisional patent application serial no. 60/270,007, attorney docket no. 25791.50, filed on 2/20/2001, (29) U.S. patent application serial no. 10/465,835, filed on 6/13/03, attorney docket no. 25791.51.06, which claims priority from provisional patent application serial no. 60/262,434, attorney docket no. 25791.51, filed on 1/17/2001, (30) U.S. patent application serial no. 10/465,831, filed on 6/13/03, attorney docket no. 25791.52.06, which claims priority from U.S. provisional patent application serial no. 60/259,486, attorney docket no. 25791.52, filed on 1/3/2001, (31) U.S. provisional patent application serial no. 60/452,303, filed on 3/5/03, attorney docket no. 25791.53, (32) U.S. patent number 6,470,966, which was filed as patent application serial number 09/850,093, filed on 5/7/01, attorney docket no. 25791.55, as a divisional application of U.S. Patent Number 6,497,289, which was filed as U.S. Patent Application serial no. 09/454,139, attorney docket no. 25791.03.02, filed on 12/3/1999, which claims priority from provisional application 60/111,293, filed on 12/7/98, (33) U.S. patent number 6,561,227, which was filed as patent application serial number 09/852,026, filed on 5/9/01, attorney docket no. 25791.56, as a divisional application of U.S. Patent Number 6,497,289, which was filed as U.S. Patent Application serial no. 09/454,139, attorney docket no. 25791.03.02, filed on 12/3/1999, which claims priority from provisional application 60/111,293, filed on 12/7/98, (34) U.S. patent application serial number 09/852,027, filed on 5/9/01, attorney docket no. 25791.57, as a divisional application of U.S. Patent Number 6,497,289, which was filed as U.S. Patent Application serial no. 09/454,139, attorney docket no. 25791.03.02, filed on 12/3/1999, which claims priority from provisional application 60/111,293, filed on 12/7/98, (35) PCT Application US02/25608, attorney docket no. 25791.58.02, filed on 8/13/02, which claims priority from provisional application 60/318,021, filed on 9/7/01, attorney docket no. 25791.58, (36) PCT Application US02/24399, attorney docket no. 25791.59.02, filed on 8/1/02, which claims priority from U.S. provisional patent application serial no. 60/313,453, attorney docket no. 25791.59, filed on 8/20/2001, (37) PCT Application US02/29856, attorney docket no. 25791.60.02, filed on 9/19/02, which claims priority from U.S. provisional patent application serial no. 60/326,886, attorney docket no. 25791.60, filed on 10/3/2001, (38) PCT Application US02/20256, attorney docket no. 25791.61.02, filed on 6/26/02, which claims priority from U.S. provisional patent application serial no.

60/303,740, attorney docket no. 25791.61, filed on 7/6/2001, (39) U.S. patent application serial no. 09/962,469, filed on 9/25/01, attorney docket no. 25791.62, which is a divisional of U.S. patent application serial no. 09/523,468, attorney docket no. 25791.11.02, filed on 3/10/2000, which claims priority from provisional application 60/124,042, filed on 3/11/99, (40) U.S. patent application serial no. 09/962,470, filed on 9/25/01, attorney docket no. 25791.63, which is a divisional of U.S. patent application serial no. 09/523,468, attorney docket no. 25791.11.02, filed on 3/10/2000, which claims priority from provisional application 60/124,042, filed on 3/11/99, (41) U.S. patent application serial no. 09/962,471, filed on 9/25/01, attorney docket no. 25791.64, which is a divisional of U.S. patent application serial no. 09/523,468, attorney docket no. 25791.11.02, filed on 3/10/2000, which claims priority from provisional application 60/124,042, filed on 3/11/99, (42) U.S. patent application serial no. 09/962,467, filed on 9/25/01, attorney docket no. 25791.65, which is a divisional of U.S. patent application serial no. 09/523,468, attorney docket no. 25791.11.02, filed on 3/10/2000, which claims priority from provisional application 60/124,042, filed on 3/11/99, (43) U.S. patent application serial no. 09/962,468, filed on 9/25/01, attorney docket no. 25791.66, which is a divisional of U.S. patent application serial no. 09/523,468, attorney docket no. 25791.11.02, filed on 3/10/2000, which claims priority from provisional application 60/124,042, filed on 3/11/99, (44) PCT application US 02/25727, filed on 8/14/02, attorney docket no. 25791.67.03, which claims priority from U.S. provisional patent application serial no. 60/317,985, attorney docket no. 25791.67, filed on 9/6/2001, and U.S. provisional patent application serial no. 60/318,386, attorney docket no. 25791.67.02, filed on 9/10/2001, (45) PCT application US 02/39425, filed on 12/10/02, attorney docket no. 25791.68.02, which claims priority from U.S. provisional patent application serial no. 60/343,674, attorney docket no. 25791.68, filed on 12/27/2001, (46) U.S. utility patent application serial no. 09/969,922, attorney docket no. 25791.69, filed on 10/3/2001, which is a continuation-in-part application of U.S. patent no. 6,328,113, which was filed as U.S. Patent Application serial number 09/440,338, attorney docket number 25791.9.02, filed on 11/15/99, which claims priority from provisional application 60/108,558, filed on 11/16/98, (47) U.S. utility patent application serial no. 10/516,467, attorney docket no. 25791.70, filed on 12/10/01, which is a

continuation application of U.S. utility patent application serial no. 09/969,922, attorney docket no. 25791.69, filed on 10/3/2001, which is a continuation-in-part application of U.S. patent no. 6,328,113, which was filed as U.S. Patent Application serial number 09/440,338, attorney docket number 25791.9.02, filed on 11/15/99, which claims priority from provisional application 60/108,558, filed on 11/16/98, (48) PCT application US 03/00609, filed on 1/9/03, attorney docket no. 25791.71.02, which claims priority from U.S. provisional patent application serial no. 60/357,372, attorney docket no. 25791.71, filed on 2/15/02, (49) U.S. patent application serial no. 10/074,703, attorney docket no. 25791.74, filed on 2/12/02, which is a divisional of U.S. patent number 6,568,471, which was filed as patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, which claims priority from provisional application 60/121,841, filed on 2/26/99, (50) U.S. patent application serial no. 10/074,244, attorney docket no. 25791.75, filed on 2/12/02, which is a divisional of U.S. patent number 6,568,471, which was filed as patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, which claims priority from provisional application 60/121,841, filed on 2/26/99, (51) U.S. patent application serial no. 10/076,660, attorney docket no. 25791.76, filed on 2/15/02, which is a divisional of U.S. patent number 6,568,471, which was filed as patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, which claims priority from provisional application 60/121,841, filed on 2/26/99, (52) U.S. patent application serial no. 10/076,661, attorney docket no. 25791.77, filed on 2/15/02, which is a divisional of U.S. patent number 6,568,471, which was filed as patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, which claims priority from provisional application 60/121,841, filed on 2/26/99, (53) U.S. patent application serial no. 10/076,659, attorney docket no. 25791.78, filed on 2/15/02, which is a divisional of U.S. patent number 6,568,471, which was filed as patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, which claims priority from provisional application 60/121,841, filed on 2/26/99, (54) U.S. patent application serial no. 10/078,928, attorney docket no. 25791.79, filed on 2/20/02, which is a divisional of U.S. patent number 6,568,471, which was filed as patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, which claims priority from provisional application

60/121,841, filed on 2/26/99, (55) U.S. patent application serial no. 10/078,922, attorney docket no. 25791.80, filed on 2/20/02, which is a divisional of U.S. patent number 6,568,471, which was filed as patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, which claims priority from provisional application 60/121,841, filed on 2/26/99, (56) U.S. patent application serial no. 10/078,921, attorney docket no. 25791.81, filed on 2/20/02, which is a divisional of U.S. patent number 6,568,471, which was filed as patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, which claims priority from provisional application 60/121,841, filed on 2/26/99, (57) U.S. patent application serial no. 10/261,928, attorney docket no. 25791.82, filed on 10/1/02, which is a divisional of U.S. patent number 6,557,640, which was filed as patent application serial no. 09/588,946, attorney docket no. 25791.17.02, filed on 6/7/2000, which claims priority from provisional application 60/137,998, filed on 6/7/99, (58) U.S. patent application serial no. 10/079,276, attorney docket no. 25791.83, filed on 2/20/02, which is a divisional of U.S. patent number 6,568,471, which was filed as patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, which claims priority from provisional application 60/121,841, filed on 2/26/99, (59) U.S. patent application serial no. 10/262,009, attorney docket no. 25791.84, filed on 10/1/02, which is a divisional of U.S. patent number 6,557,640, which was filed as patent application serial no. 09/588,946, attorney docket no. 25791.17.02, filed on 6/7/2000, which claims priority from provisional application 60/137,998, filed on 6/7/99, (60) U.S. patent application serial no. 10/092,481, attorney docket no. 25791.85, filed on 3/7/02, which is a divisional of U.S. patent number 6,568,471, which was filed as patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, which claims priority from provisional application 60/121,841, filed on 2/26/99, (61) U.S. patent application serial no. 10/261,926, attorney docket no. 25791.86, filed on 10/1/02, which is a divisional of U.S. patent number 6,557,640, which was filed as patent application serial no. 09/588,946, attorney docket no. 25791.17.02, filed on 6/7/2000, which claims priority from provisional application 60/137,998, filed on 6/7/99, (62) PCT application US 02/36157, filed on 11/12/02, attorney docket no. 25791.87.02, which claims priority from U.S. provisional patent application serial no. 60/338,996, attorney docket no. 25791.87, filed on 11/12/01, (63)

PCT application US 02/36267, filed on 11/12/02, attorney docket no. 25791.88.02, which claims priority from U.S. provisional patent application serial no. 60/339,013, attorney docket no. 25791.88, filed on 11/12/01, (64) PCT application US 03/11765, filed on 4/16/03, attorney docket no. 25791.89.02, which claims priority from U.S. provisional patent application serial no. 60/383,917, attorney docket no. 25791.89, filed on 5/29/02, (65) PCT application US 03/15020, filed on 5/12/03, attorney docket no. 25791.90.02, which claims priority from U.S. provisional patent application serial no. 60/391,703, attorney docket no. 25791.90, filed on 6/26/02, (66) PCT application US 02/39418, filed on 12/10/02, attorney docket no. 25791.92.02, which claims priority from U.S. provisional patent application serial no. 60/346,309, attorney docket no. 25791.92, filed on 1/7/02, (67) PCT application US 03/06544, filed on 3/4/03, attorney docket no. 25791.93.02, which claims priority from U.S. provisional patent application serial no. 60/372,048, attorney docket no. 25791.93, filed on 4/12/02, (68) U.S. patent application serial no. 10/331,718, attorney docket no. 25791.94, filed on 12/30/02, which is a divisional U.S. patent application serial no. 09/679,906, filed on 10/5/00, attorney docket no. 25791.37.02, which claims priority from provisional patent application serial no. 60/159,033, attorney docket no. 25791.37, filed on 10/12/1999, (69) PCT application US 03/04837, filed on 2/29/03, attorney docket no. 25791.95.02, which claims priority from U.S. provisional patent application serial no. 60/363,829, attorney docket no. 25791.95, filed on 3/13/02, (70) U.S. patent application serial no. 10/261,927, attorney docket no. 25791.97, filed on 10/1/02, which is a divisional of U.S. patent number 6,557,640, which was filed as patent application serial no. 09/588,946, attorney docket no. 25791.17.02, filed on 6/7/2000, which claims priority from provisional application 60/137,998, filed on 6/7/99, (71) U.S. patent application serial no. 10/262,008, attorney docket no. 25791.98, filed on 10/1/02, which is a divisional of U.S. patent number 6,557,640, which was filed as patent application serial no. 09/588,946, attorney docket no. 25791.17.02, filed on 6/7/2000, which claims priority from provisional application 60/137,998, filed on 6/7/99, (72) U.S. patent application serial no. 10/261,925, attorney docket no. 25791.99, filed on 10/1/02, which is a divisional of U.S. patent number 6,557,640, which was filed as patent application serial no. 09/588,946, attorney docket no. 25791.17.02, filed on 6/7/2000, which claims priority from

provisional application 60/137,998, filed on 6/7/99, (73) U.S. patent application serial no. 10/199,524, attorney docket no. 25791.100, filed on 7/19/02, which is a continuation of U.S. Patent Number 6,497,289, which was filed as U.S. Patent Application serial no. 09/454,139, attorney docket no. 25791.03.02, filed on 12/3/1999, which claims priority from provisional application 60/111,293, filed on 12/7/98, (74) PCT application US 03/10144, filed on 3/28/03, attorney docket no. 25791.101.02, which claims priority from U.S. provisional patent application serial no. 60/372,632, attorney docket no. 25791.101, filed on 4/15/02, (75) U.S. provisional patent application serial no. 60/412,542, attorney docket no. 25791.102, filed on 9/20/02, (76) PCT application US 03/14153, filed on 5/6/03, attorney docket no. 25791.104.02, which claims priority from U.S. provisional patent application serial no. 60/380,147, attorney docket no. 25791.104, filed on 5/6/02, (77) PCT application US 03/19993, filed on 6/24/03, attorney docket no. 25791.106.02, which claims priority from U.S. provisional patent application serial no. 60/397,284, attorney docket no. 25791.106, filed on 7/19/02, (78) PCT application US 03/13787, filed on 5/5/03, attorney docket no. 25791.107.02, which claims priority from U.S. provisional patent application serial no. 60/387,486, attorney docket no. 25791.107, filed on 6/10/02, (79) PCT application US 03/18530, filed on 6/11/03, attorney docket no. 25791.108.02, which claims priority from U.S. provisional patent application serial no. 60/387,961, attorney docket no. 25791.108, filed on 6/12/02, (80) PCT application US 03/20694, filed on 7/1/03, attorney docket no. 25791.110.02, which claims priority from U.S. provisional patent application serial no. 60/398,061, attorney docket no. 25791.110, filed on 7/24/02, (81) PCT application US 03/20870, filed on 7/2/03, attorney docket no. 25791.111.02, which claims priority from U.S. provisional patent application serial no. 60/399,240, attorney docket no. 25791.111, filed on 7/29/02, (82) U.S. provisional patent application serial no. 60/412,487, attorney docket no. 25791.112, filed on 9/20/02, (83) U.S. provisional patent application serial no. 60/412,488, attorney docket no. 25791.114, filed on 9/20/02, (84) U.S. patent application serial no. 10/280,356, attorney docket no. 25791.115, filed on 10/25/02, which is a continuation of U.S. patent number 6,470,966, which was filed as patent application serial number 09/850,093, filed on 5/7/01, attorney docket no. 25791.55, as a divisional application of U.S. Patent Number 6,497,289,

which was filed as U.S. Patent Application serial no. 09/454,139, attorney docket no. 25791.03.02, filed on 12/3/1999, which claims priority from provisional application 60/111,293, filed on 12/7/98, (85) U.S. provisional patent application serial no. 60/412,177, attorney docket no. 25791.117, filed on 9/20/02, (86) U.S. provisional patent application serial no. 60/412,653, attorney docket no. 25791.118, filed on 9/20/02, (87) U.S. provisional patent application serial no. 60/405,610, attorney docket no. 25791.119, filed on 8/23/02, (88) U.S. provisional patent application serial no. 60/405,394, attorney docket no. 25791.120, filed on 8/23/02, (89) U.S. provisional patent application serial no. 60/412,544, attorney docket no. 25791.121, filed on 9/20/02, (90) PCT application US 03/24779, filed on 8/8/03, attorney docket no. 25791.125.02, which claims priority from U.S. provisional patent application serial no. 60/407,442, attorney docket no. 25791.125, filed on 8/30/02, (91) U.S. provisional patent application serial no. 60/423,363, attorney docket no. 25791.126, filed on 12/10/02, (92) U.S. provisional patent application serial no. 60/412,196, attorney docket no. 25791.127, filed on 9/20/02, (93) U.S. provisional patent application serial no. 60/412,187, attorney docket no. 25791.128, filed on 9/20/02, (94) U.S. provisional patent application serial no. 60/412,371, attorney docket no. 25791.129, filed on 9/20/02, (95) U.S. patent application serial no. 10/382,325, attorney docket no. 25791.145, filed on 3/5/03, which is a continuation of U.S. patent number 6,557,640, which was filed as patent application serial no. 09/588,946, attorney docket no. 25791.17.02, filed on 6/7/2000, which claims priority from provisional application 60/137,998, filed on 6/7/99, (96) U.S. patent application serial no. 10/624,842, attorney docket no. 25791.151, filed on 7/22/03, which is a divisional of U.S. patent application serial no. 09/502,350, attorney docket no. 25791.8.02, filed on 2/10/2000, which claims priority from provisional application 60/119,611, filed on 2/11/99, (97) U.S. provisional patent application serial no. 60/431,184, attorney docket no. 25791.157, filed on 12/5/02, (98) U.S. provisional patent application serial no. 60/448,526, attorney docket no. 25791.185, filed on 2/18/03, (99) U.S. provisional patent application serial no. 60/461,539, attorney docket no. 25791.186, filed on 4/9/03, (100) U.S. provisional patent application serial no. 60/462,750, attorney docket no. 25791.193, filed on 4/14/03, (101) U.S. provisional patent application serial no. 60/436,106, attorney docket

no. 25791.200, filed on 12/23/02, (102) U.S. provisional patent application serial no. 60/442,942, attorney docket no. 25791.213, filed on 1/27/03, (103) U.S. provisional patent application serial no. 60/442,938, attorney docket no. 25791.225, filed on 1/27/03, (104) U.S. provisional patent application serial no. 60/418,687, attorney docket no. 25791.228, filed on 4/18/03, (105) U.S. provisional patent application serial no. 60/454,896, attorney docket no. 25791.236, filed on 3/14/03, (106) U.S. provisional patent application serial no. 60/450,504, attorney docket no. 25791.238, filed on 2/26/03, (107) U.S. provisional patent application serial no. 60/451,152, attorney docket no. 25791.239, filed on 3/9/03, (108) U.S. provisional patent application serial no. 60/455,124, attorney docket no. 25791.241, filed on 3/17/03, (109) U.S. provisional patent application serial no. 60/453,678, attorney docket no. 25791.253, filed on 3/11/03, (110) U.S. patent application serial no. 10/421,682, attorney docket no. 25791.256, filed on 4/23/03, which is a continuation of U.S. patent application serial no. 09/523,468, attorney docket no. 25791.11.02, filed on 3/10/2000, which claims priority from provisional application 60/124,042, filed on 3/11/99, (111) U.S. provisional patent application serial no. 60/457,965, attorney docket no. 25791.260, filed on 3/27/03, (112) U.S. provisional patent application serial no. 60/455,718, attorney docket no. 25791.262, filed on 3/18/03, (113) U.S. patent number 6,550,821, which was filed as patent application serial no. 09/811,734, filed on 3/19/01, (114) U.S. patent application serial no. 10/436,467, attorney docket no. 25791.268, filed on 5/12/03, which is a continuation of U.S. patent number 6,604,763, which was filed as application serial no. 09/559,122, attorney docket no. 25791.23.02, filed on 4/26/2000, which claims priority from provisional application 60/131,106, filed on 4/26/99, (115) U.S. provisional patent application serial no. 60/459,776, attorney docket no. 25791.270, filed on 4/2/03, (116) U.S. provisional patent application serial no. 60/461,094, attorney docket no. 25791.272, filed on 4/8/03, (117) U.S. provisional patent application serial no. 60/461,038, attorney docket no. 25791.273, filed on 4/7/03, (118) U.S. provisional patent application serial no. 60/463,586, attorney docket no. 25791.277, filed on 4/17/03, (119) U.S. provisional patent application serial no. 60/472,240, attorney docket no. 25791.286, filed on 5/20/03, (120) U.S. patent application serial no. 10/619,285, attorney docket no. 25791.292, filed on 7/14/03, which is a continuation-in-part of U.S.

utility patent application serial no. 09/969,922, attorney docket no. 25791.69, filed on 10/3/2001, which is a continuation-in-part application of U.S. patent no. 6,328,113, which was filed as U.S. Patent Application serial number 09/440,338, attorney docket number 25791.9.02, filed on 11/15/99, which claims priority from provisional application 60/108,558, filed on 11/16/98, (121) U.S. utility patent application serial no. 10/418,688, attorney docket no. 25791.257, which was filed on 4/18/03, as a division of U.S. utility patent application serial no. 09/523,468, attorney docket no. 25791.11.02, filed on 3/10/2000, which claims priority from provisional application 60/124,042, filed on 3/11/99, (122) PCT patent application serial no. PCT/US2004/06246, attorney docket no. 25791.238.02, filed on 2/26/2004, (123) PCT patent application serial number PCT/US2004/08170, attorney docket number 25791.40.02, filed on 3/15/04, (124) PCT patent application serial number PCT/US2004/08171, attorney docket number 25791.236.02, filed on 3/15/04, (125) PCT patent application serial number PCT/US2004/08073, attorney docket number 25791.262.02, filed on 3/18/04, (126) PCT patent application serial number PCT/US2004/07711, attorney docket number 25791.253.02, filed on 3/11/2004, (127) PCT patent application serial number PCT/US2004/029025, attorney docket number 25791.260.02, filed on 3/26/2004, (128) PCT patent application serial number PCT/US2004/010317, attorney docket number 25791.270.02, filed on 4/2/2004, (129) PCT patent application serial number PCT/US2004/010712, attorney docket number 25791.272.02, filed on 4/6/2004, (130) PCT patent application serial number PCT/US2004/010762, attorney docket number 25791.273.02, filed on 4/6/2004, (131) PCT patent application serial number PCT/US2004/011973, attorney docket number 25791.277.02, filed on 4/15/2004, (132) U.S. provisional patent application serial number 60/495056, attorney docket number 25791.301, filed on 8/14/2003, (133) U.S. provisional patent application serial number 60/600679, attorney docket number 25791.194, filed on 8/11/2004, (134) PCT patent application serial number PCT/US2005/027318, attorney docket number 25791.329.02, filed on 7/29/2005, the disclosures of which are incorporated herein by reference. (135) PCT patent application serial number PCT/US2005/028936, attorney docket number 25791.338.02, filed on 8/12/2005, (136) PCT patent application serial number PCT/US2005/028669, attorney docket number 25791.194.02, filed on 8/11/2005, (137)

PCT patent application serial number PCT/US2005/028453, attorney docket number 25791.371, filed on 8/11/2005, (138) PCT patent application serial number PCT/US2005/028641, attorney docket number 25791.372, filed on 8/11/2005, (139) PCT patent application serial number PCT/US2005/028819, attorney docket number 25791.373, filed on 8/11/2005, (140) PCT patent application serial number PCT/US2005/028446, attorney docket number 25791.374, filed on 8/11/2005, (141) PCT patent application serial number PCT/US2005/028642, attorney docket number 25791.375, filed on 8/11/2005, (142) PCT patent application serial number PCT/US2005/028451, attorney docket number 25791.376, filed on 8/11/2005, and (143). PCT patent application serial number PCT/US2005/028473, attorney docket number 25791.377, filed on 7/29/2005, (144) U.S. National Stage application serial no. 10/546084, attorney docket no. 25791.185.05, filed on 8/17/2005; (145) U.S. National Stage application serial no. 10/546082, attorney docket no. 25791.378, filed on 8/17/2005; (146) U.S. National Stage application serial no. 10/546076, attorney docket no. 25791.379, filed on 8/17/2005; (147) U.S. National Stage application serial no. 10/546936, attorney docket no. 25791.380, filed on 8/17/2005; (148) U.S. National Stage application serial no. 10/546079, attorney docket no. 25791.381, filed on 8/17/2005; (149) U.S. National Stage application serial no. 10/545941, attorney docket no. 25791.382, filed on 8/17/2005; (150) U.S. National Stage application serial no. 10/546078, attorney docket no. 25791.383, filed on 8/17/2005 the disclosures of which are incorporated herein by reference.

[0003] This application is also related to the following co-pending applications: (151) U.S. utility patent application serial number 11/249967, attorney docket number 25791.384, filed on 10/13/2005, (152) U.S. provisional patent application serial number 60/734302, attorney docket number 25791.24, filed on 11/7/2005, (153) U.S. provisional patent application serial number 60/725181, attorney docket number 25791.184, filed on 10/11/2005, (154) PCT patent application serial number PCT/US2005/023391, attorney docket number 25791.299.02 filed 6/29/2005 which claims priority from U.S. provisional patent application serial number 60/585370, attorney docket number 25791.299, filed on 7/2/2004, (155) U.S. provisional patent application serial number 60/721579, attorney docket number 25791.327, filed on 9/28/2005, (156) U.S.

provisional patent application serial number 60/717391, attorney docket number 25791.214, filed on 9/15/2005, (157) U.S. provisional patent application serial number 60/702935, attorney docket number 25791.133, filed on 7/27/2005, (158) U.S. provisional patent application serial number 60/663913, attorney docket number 25791.32, filed on 3/21/2005, (159) U.S. provisional patent application serial number 60/652564, attorney docket number 25791.348, filed on 2/14/2005, (160) U.S. provisional patent application serial number 60/645840, attorney docket number 25791.324, filed on 1/21/2005, (161) PCT patent application serial number PCT/US2005/043122, attorney docket number 25791.326.02, filed on 11/29/2005 which claims priority from U.S. provisional patent application serial number 60/631703, attorney docket number 25791.326, filed on 11/30/2004, (162) U.S. provisional patent application serial number 60/752787, attorney docket number 25791.339, filed on 12/22/2005, (163) U.S. National Stage application serial no. 10/548934, attorney docket no. 25791.253.05, filed on 9/12/2005; (164) U.S. National Stage application serial no. 10/549410, attorney docket no. 25791.262.05, filed on 9/13/2005; (165) U.S. Provisional Patent Application No. 60/717391, attorney docket no. 25791.214 filed on 9/15/2005; (166) U.S. National Stage application serial no. 10/550906, attorney docket no. 25791.260.06, filed on 9/27/2005; (167) U.S. National Stage application serial no. 10/551880, attorney docket no. 25791.270.06, filed on 9/30/2005; (168) U.S. National Stage application serial no. 10/552253, attorney docket no. 25791.273.06, filed on 10/4/2005; (169) U.S. National Stage application serial no. 10/552790, attorney docket no. 25791.272.06, filed on 10/11/2005; (170) U.S. Provisional Patent Application No. 60/725181, attorney docket no. 25791.184 filed on 10/11/2005; (171) U.S. National Stage application serial no. 10/553094, attorney docket no. 25791.193.03, filed on 10/13/2005; (172) U.S. National Stage application serial no. 10/553566, attorney docket no. 25791.277.06, filed on 10/17/05; (173) PCT Patent Application No. PCT/US2006/002449, attorney docket no. 25791.324.02 filed on 1/20/06, (174) PCT Patent Application No. PCT/US2006/004809, attorney docket no. 25791.348.02 filed on 2/9/06; (175) U.S. Utility Patent application serial no. 11/356899, attorney docket no. 25791.386, filed on 2/17/06, (176) U.S. National Stage application serial no. 10/568200, attorney docket no. 25791.301.06, filed on 2/13/2006, (177) U.S. National Stage

application serial no. 10/568719, attorney docket no. 25791.137.04, filed on 2/16/06, (178) U.S. National Stage application serial no. 10/569323, attorney docket no. 25791.215.06, filed on 2/17/06, (179) U.S. National State patent application serial no. 10/571041, attorney docket no. 25791.305.05, filed on 3/3/06; (180) U.S. National State patent application serial no. 10/571017, attorney docket no. 25791.306.04, filed on 3/3/06; (181) U.S. National State patent application serial no. 10/571086, attorney docket no. 25791.307.04, filed on 3/6/06; and (182) U.S. National State patent application serial no. 10/571085, attorney docket no. 25791.308.07, filed on 3/6/06, (183) U.S. utility patent application serial number 10/938788, attorney docket number 25791.330, filed on 9/10/04, (184) U.S. utility patent application serial number 10/938225, attorney docket number 25791.331, filed on 9/10/04, (185) U.S. utility patent application serial number 10/952288, attorney docket number 25791.332, filed on 9/28/04, (186) U.S. utility patent application serial number 10/952416, attorney docket number 25791.333, filed on 9/28/04, (187) U.S. utility patent application serial number 10/950749, attorney docket number 25791.334, filed on 9/27/04, (188) U.S. utility patent application serial number 10/950869, attorney docket number 25791.335, filed on 9/27/04; (189) U.S. provisional patent application serial number 60/761324, attorney docket number 25791.340, filed on 1/23/06, (190) U.S. provisional patent application serial number 60/754556, attorney docket number 25791.342, filed on 12/28/05, (191) U.S. utility patent application serial number 11/380051, attorney docket number 25791.388, filed on 4/25/06, (192) U.S. utility patent application serial number 11/380055, attorney docket number 25791.389, filed on 4/25/06, (193) U.S. utility patent application serial number 10/522039, attorney docket number 25791.106.05, filed on 3/10/2006; (194) U.S. provisional patent application serial number 60/746,813, attorney docket number 25791.259, filed on 5/9/2006; (195) U.S. utility patent application serial number 11/456584, attorney docket number 25791.403, filed on 7/11/2006; and (196) U.S. utility patent application serial number 11/456587, attorney docket number 25791.404, filed on 7/11/2006; (197) PCT Patent Application No. PCT/US2006/009886, attorney docket no. 25791.32.02 filed on 3/21/2006; (198) PCT Patent Application No. PCT/US2006/010674, attorney docket no. 25791.337.02 filed on 3/21/2006; (199) U.S. Patent 6,409,175 which issued 6/25/2002, attorney docket no. 25791.159; (200) U.S.

Patent 6,550,821 which issued 4/22/2003, attorney docket no. 25791.263; (201) U.S. Patent Application No. 10/767,953, filed 1/29/2004, attorney docket no. 25791.309, now U.S. Patent 7077211 which issued 7/18/2006; (202) U.S. Patent Application No. 10/769,726, filed 1/30/2004, attorney docket no. 25791.310; (203) U.S. Patent Application No. 10/770363 filed 2/2/2004, attorney docket no. 25791.311; (204) U.S. utility patent application serial no. 11/068,595, attorney docket no. 25791.349, filed on 2/28/2005; (205) U.S. utility patent application serial no. 11/070,147, attorney docket no. 25791.351, filed on 3/2/2005; (206) U.S. utility patent application serial no. 11/071,409, attorney docket no. 25791.352, filed on 3/2/2005; (207) U.S. utility patent application serial no. 11/071,557, attorney docket no. 25791.353, filed on 3/3/2005; (208) U.S. utility patent application serial no. 11/072,578, attorney docket no. 25791.354, filed on 3/4/2005; (209) U.S. utility patent application serial no. 11/072,893, attorney docket no. 25791.355, filed on 3/4/2005; (210) U.S. utility patent application serial no. 11/072,594, attorney docket no. 25791.356, filed on 3/4/2005; (211) U.S. utility patent application serial no. 11/074,366, attorney docket no. 25791.357, filed on 3/7/2005; (212) U.S. utility patent application serial no. 11/074,266, attorney docket no. 25791.358, filed on 3/7/2005, (213) U.S. provisional patent application serial no. 60/832909, attorney docket no. 25791.407, filed on 7/24/2006, (214) U.S. utility patent application serial no. 11/536,302, attorney docket no. 25791.412, filed 9/28/2006, and (215) U.S. utility patent application serial no. 11/538228, attorney docket no. 25791.156, filed 10/3/06.

BACKGROUND OF THE INVENTION

[0004] The present disclosure relates to drilling a borehole in a subterranean formation, and more particularly to an apparatus and a method for making and using the apparatus, to form casing and/or repair casing in the borehole using expandable tubing.

[0005] Conventionally, when a wellbore is created, a number of casings are installed in the borehole to prevent collapse of the borehole wall and to prevent undesired outflow of drilling fluid into the formation or inflow of fluid from the formation into the borehole. The borehole is drilled in intervals whereby a casing which is to be installed in a lower borehole interval is lowered through a previously installed casing of an upper borehole interval. As a consequence of this procedure the casing of the lower interval is of smaller diameter than the casing of the upper interval. Thus, the casings are in a

nested arrangement with casing diameters decreasing in downward direction. Cement annuli are provided between the outer surfaces of the casings and the borehole wall to seal the casings from the borehole wall. As a consequence of this nested arrangement a relatively large borehole diameter is required at the upper part of the wellbore. Such a large borehole diameter involves increased costs due to heavy casing handling equipment, large drill bits and increased volumes of drilling fluid and drill cuttings. Moreover, increased drilling rig time is involved due to required cement pumping, cement hardening, required equipment changes due to large variations in hole diameters drilled in the course of the well, and the large volume of cuttings drilled and removed.

[0006] The present invention is directed to overcoming one or more of the limitations of the existing procedures for forming wellbores.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Figure 1 is an illustration of a conventional method for drilling a borehole in a subterranean formation;

Figure 2 is an illustration of a device for coupling an expandable tubular member to an existing tubular member;

Figure 3 is an illustration of a hardenable fluidic sealing material being pumped down the device of Figure 2;

Figure 4 is an illustration of the expansion of an expandable tubular member using the expansion device of Figure 2;

Figure 5 is an illustration of the completion of the radial expansion and plastic deformation of an expandable tubular member;

Figure 6 is a longitudinal cross sectional view of an exemplary embodiment of an expandable tubular member;

Figure 7 is a flow chart illustration of an exemplary embodiment of a method of manufacturing an expandable tubular member;

Figures 8, 9, 10, 11, and 12 are longitudinal cross sectional views of exemplary embodiments of the method of manufacturing an expandable tubular member of Figure 7;

Figure 13 is a longitudinal cross sectional view of an exemplary embodiment of an expansion device of Figure 2;

Figure 14 is a longitudinal cross sectional view of another exemplary embodiment of an expansion device of Figure 2;

Figure 15a is a longitudinal cross sectional view of an exemplary embodiment of an expandable tubular member;

Figure 15b is a longitudinal cross sectional view of an exemplary embodiment of a sealing member on the intermediate section of an expandable tubular member;

Figure 15c is a longitudinal cross sectional view of an exemplary embodiment of a sealing member;

Figure 16 is a longitudinal cross sectional view of another exemplary embodiment of an expandable tubular member;

Figure 17 is a radial cross sectional view of the expandable tubular member of Figure 16;

Figure 18 is a longitudinal cross sectional view of another exemplary embodiment of an expandable tubular member;

Figure 19 is a radial cross sectional view of the expandable tubular member of Figure 18;

Figure 20 is an illustration of an exemplary embodiment of the device of Figure 2.

DETAILED DESCRIPTION OF THE DRAWINGS

[0008] Referring initially to Figure 1, a conventional device 100 for drilling a borehole 102 in a subterranean formation 104 is shown. The borehole 102 may be lined with casing 106 at the top portion of its length. An annulus 108 formed between the casing 106 and the formation 104 may be filled with a sealing material 110, such as, for example, cement. In an exemplary embodiment, the device 100 may be operated in a conventional manner to extend the length of the borehole 102 beyond the casing 106.

[0009] Referring now to Figure 2, a device 200 for coupling an expandable tubular member 202 to an existing tubular member, such as, for example, the existing casing 106, is shown. The device 200 includes a shoe 206 that defines a centrally positioned valveable passage 206a adapted to receive, for example, a ball, plug or other similar device for closing the passage. An end of the shoe 206b is coupled to a lower tubular

end 208a of a tubular launcher assembly 208 that includes the lower tubular end, an upper tubular end 208b, and a tapered tubular transition member 208c. The lower tubular end 208a of the tubular launcher assembly 208 has a greater inside diameter than the inside diameter of the upper tubular end 208b. The tapered tubular transition member 208c connects the lower tubular end 208a and the upper tubular end 208b. The upper tubular end 208b of the tubular launcher assembly 208 is coupled to an end of the expandable tubular member 202. One or more seals 210 are coupled to the outside surface of the other end of the expandable tubular member 202.

[0010] An expansion device 212 is centrally positioned within and mates with the tubular launcher assembly 208. The expansion device 212 defines a centrally positioned fluid pathway 212a, and includes a lower section 212b, a middle section 212c, and an upper section 212d. The lower section 212b of the expansion device 212 defines an inclined expansion surface 212ba that supports the tubular launcher assembly 208 by mating with the tapered tubular transition member 208c of the tubular launcher assembly. The upper section 212d of the expansion device 212 is coupled to an end of a tubular member 218 that defines a fluid pathway 218a. The fluid pathway 218a of the tubular member 218 is fluidically coupled to the fluid pathway 212a defined by the expansion device 212. One or more spaced apart cup seals 220 and 222 are coupled to the outside surface of the tubular member 218 for sealing against the interior surface of the expandable tubular member 202. In an exemplary embodiment, cup seal 222 is positioned near a top end of the expandable tubular member 202. A top fluid valve 224 is coupled to the tubular member 218 above the cup seal 222 and defines a fluid pathway 226 that is fluidically coupled to the fluid pathway 218a.

[0011] During operation of the device 200, as illustrated in Figure 2, the device 200 is initially lowered into the borehole 102. In an exemplary embodiment, during the lowering of the device 200 into the borehole 102, a fluid 228 within the borehole 102 passes upwardly through the device 200 through the valveable passage 206a into the fluid pathway 212a and 218a and out of the device 200 through the fluid pathway 226 defined by the top fluid valve 224.

[0012] Referring now to Figure 3, in an exemplary embodiment, a hardenable fluidic sealing material 300, such as, for example, cement, is then pumped down the fluid

pathway 218a and 212a and out through the valveable passage 206a into the borehole 102 with the top fluid valve 224 in a closed position. The hardenable fluidic sealing material 300 thereby fills an annular space 302 between the borehole 102 and the outside diameter of the expandable tubular member 102.

[0013] Referring now to Figure 4, a plug 402 is then injected with a fluidic material 404. The plug thereby fits into and closes the valveable passage 206a to further fluidic flow. Continued injection of the fluidic material 404 then pressurizes the chamber 406 defined by the shoe 206, the bottom of the expansion device 212, and the walls of the launcher assembly 208 and the expandable tubular member 202. Continued pressurization of the chamber 406 then displaces the expansion device 212 in an upward direction 408 relative to the expandable tubular member 202 thereby causing radial expansion and plastic deformation of the launcher assembly 208 and the expandable tubular member.

[0014] Referring now to Figure 5, the radial expansion and plastic deformation of the expandable tubular member 202 is then complete and the expandable tubular member is coupled to the existing casing 106. The hardenable fluidic sealing material 300, such as, for example, cement fills the annulus 302 between the expandable tubular member 202 and the borehole 102. The device 200 has been withdrawn from the borehole and a conventional device 100 for drilling the borehole 102 may then be utilized to drill out the shoe 206 and continue drilling the borehole 102, if desired.

[0015] Referring now to Figure 6, an exemplary embodiment of an expandable tubular member 600 defines a first tubular section 602 having a connection means on one end, such as, for example, female threads 604. One or more seals 606 are coupled to the outside surface of the first tubular section 602. An end of the first tubular section 602 is coupled to an intermediate tubular section 608 having a smaller inside diameter than the first tubular section by a first tapered tubular transition member 610. One or more seals 612 are coupled to the outside surface of the intermediate tubular section 608. The intermediate tubular section 608 is coupled to a second tubular section 614 having a greater inside diameter than the intermediate tubular section by a second tapered tubular transition member 616. The second tubular section 614

includes a connection means, such as, for example, male threads 618. One or more seals 620 are coupled to the outside surface of the second tubular section 614.

[0016] In an exemplary embodiment, the expandable tubular member 202 includes one or more of the expandable tubular members 600.

[0017] Referring now to Figure 7, a method 700 of fabricating the expandable tubular member 600 is shown. In an initial step 702, as illustrated in Figure 8, a first tubular end 802 and a second tubular end 804 of an expandable tubular member 800 are upset. The first tubular upset end 802 has a wall thickness t_1 and the second tubular upset end 804 has a wall thickness t_2 . A non-expanded intermediate expandable tubular member 806 is formed between the two upset ends 802 and 804, having a wall thickness t_{INT} and a diameter D_{INT} .

[0018] Then, in steps 704 and 706, as illustrated in Figure 9, the first tubular upset end 802 and the second tubular upset end 804 of the expandable tubular member 800 are radially expanded and stress relieved. The radially expanded end 802 defines an interior diameter D_1 and wall thickness t_1 , the radially expanded end 804 defines an interior diameter D_2 and wall thickness t_2 .

[0019] In step 708, as illustrated in Figure 10, expandable threaded connections 808a and 808b are formed on the radially expanded ends 802 and 804, respectively.

[0020] In step 710, as illustrated in Figure 11, a first protective member 810a is then applied to the outside diameter of the first tubular end 802 and a second protective member 810b is applied to the outside diameter of the second tubular end 804 of the expandable tubular member 800.

[0021] Finally, in step 712, as illustrated in Figure 12, a sealing material 812 is then applied to the outside diameter of the non-expanded intermediate portion 806 of the expandable tubular member 800.

[0022] Referring now to Figure 13, an expansion cone 900 defines an upper cone 902, a middle cone 904, and a lower tubular end 906. The upper cone 902 has a leading surface 908 and an outer inclined surface 910 that defines an angle α_1 . The middle cone 904 has an outer inclined surface 912 that defines an angle α_2 . In an exemplary embodiment, the angle α_1 is greater than the angle α_2 . The outer inclined surfaces 910 and 912 together form the expansion surfaces 914 that upon displacement

of the expansion cone 900 relative to the expandable tubular member 202, radially expand and plastically deform the expandable tubular member.

[0023] Referring now to Figure 14, an exemplary embodiment of an expansion cone 1000 with an outside expansion surface 1002 defining a parabolic equation, is shown. The expansion cone 1000 has an upper expansion section 1004 and a lower tubular end 1006. The upper expansion section 1004 has a leading surface 1008 and the outside expansion surface 1008 defined by a parabolic equation.

[0024] Referring now to Figure 15a, an exemplary embodiment of an expandable tubular member 1100 defines a first tubular section 1102 having an end of the first tubular section coupled to an intermediate tubular section 1104 having a smaller inside diameter than the first tubular section by a first tapered tubular transition member 1106. One or more seals 1108 are coupled to the outside surface of the intermediate tubular section 1104. The intermediate tubular section 1104 is coupled to a second tubular section 1110 having a greater inside diameter than the intermediate tubular section by a second tapered tubular transition member 1112.

[0025] Referring now to Figure 15b, in an exemplary embodiment, a ring 1114 borders the top and bottom surfaces of the sealing member 1108. The ring 1114 fits into a groove 1116 defined on the outside surface of the intermediate tubular section 1104.

[0026] In an exemplary embodiment, as illustrated in Figure 15c, the seal 1108 includes a metal 1110 positioned between two elastomers 1112a and 1112b.

[0027] In an exemplary embodiment, the expandable tubular member 202 includes one or more of the expandable tubular members 600 and 1100.

[0028] Referring now to Figures 16 and 17, an exemplary embodiment of an expandable tubular member 1200 defines a first tubular section 1202 having an end of the first tubular section coupled to an intermediate tubular section 1204 having a smaller inside diameter than the first tubular section by a first tapered tubular transition member 1206. The intermediate tubular section 1204 includes circumferentially spaced apart radial projections 1208. In an exemplary embodiment, the circumferentially spaced apart radial projections 1208 define equally circumferentially spaced apart radial projections of approximately equal size. The intermediate tubular section 1204 is

coupled to a second tubular section 1210 having a greater inside diameter than the intermediate tubular section by a second tapered tubular transition member 1212.

[0029] In an exemplary embodiment, the expandable tubular member 202 includes one or more of the expandable tubular members 600, 1100 and 1200.

[0030] Referring now to Figures 18 and 19, an exemplary embodiment of an expandable tubular member 1300 defines a first tubular section 1302 having an end of the first tubular section coupled to an intermediate tubular section 1304 having a smaller inside diameter than the first tubular section by a first tapered tubular transition member 1306. The intermediate tubular section 1304 includes circumferential spaced apart radial projections 1308. In an exemplary embodiment, the circumferentially spaced apart radial projections 1304 define equally circumferentially spaced apart radial projections of approximately equal size. One or more sealing members 1310 are applied to the outside surface of the circumferentially spaced apart radial projections 1308. The intermediate tubular section 1304 is coupled to a second tubular section 1310 having a greater inside diameter than the intermediate tubular section by a second tapered tubular transition member 1312.

[0031] In an exemplary embodiment, the expandable tubular member 202 includes one or more of the expandable tubular members 600, 1100, 1200, and 1300.

[0032] Referring now to Figure 20, an alternative embodiment of the device 200 in which the upper end 208c and transition member 208b of the tubular launcher assembly 208 have a decreased wall thickness, is shown.

[0033] In an exemplary embodiment, the expandable tubular member 202 includes one or more of the expandable tubular members 600, 1100, 1200, and 1300. In an exemplary embodiment, the device 200 includes one or more of the expandable tubular members 600, 1100, 1200, and 1300 and one or more of the expansion cones 900 and 1000.

[0034] An expandable tubular member has been described that includes a first tubular section with a first outer diameter; an intermediate tubular section with an intermediate outer diameter coupled to the first tubular section; and a second tubular section with a second outer diameter coupled to the intermediate tubular section; wherein the first and second outer diameters are greater than the intermediate outer

diameter. The outer surface of the first tubular section includes a first sealing member; and the outer surface of the second tubular section includes a second sealing member. The outer surface of the intermediate tubular section also includes a sealing member. The sealing member may be either an elastomer, a metal, or a metal positioned between two elastomers.

[0035] An expandable tubular member has been described that includes a first tubular section with a first outer diameter; an intermediate tubular section with an intermediate outer diameter coupled to the first tubular section; and a second tubular section with a second outer diameter coupled to the intermediate tubular section; wherein the first and second outer diameters are greater than the intermediate outer diameter. The outer surface of the first tubular section includes a first sealing member; and the outer surface of the second tubular section includes a second sealing member. The intermediate tubular section includes circumferentially spaced apart radial projections. The circumferentially spaced apart radial projections include a sealing member. The sealing member may be either an elastomer or a metal.

[0036] An apparatus has been described that includes a tubular member formed by the process of radially expanding an unexpanded tubular member into contact with an approximately cylindrical passage using an expansion device, the unexpanded tubular member includes a first tubular section with a first outer diameter; an intermediate tubular section with an intermediate outer diameter coupled to the first tubular section; and a second tubular section with a second outer diameter coupled to the intermediate tubular section; wherein the first and second outer diameters are greater than the intermediate outer diameter. The outer surface of the first tubular section includes a first sealing member; and the outer surface of the second tubular section includes a second sealing member. The outer surface of the intermediate tubular section also includes a sealing member. The sealing member may be either an elastomer, a metal, or a metal positioned between two elastomers.

[0037] An apparatus has been described that includes a tubular member formed by the process of radially expanding an unexpanded tubular member into contact with an approximately cylindrical passage using an expansion device, the unexpanded tubular member includes a first tubular section with a first outer diameter; an intermediate

tubular section with an intermediate outer diameter coupled to the first tubular section; and a second tubular section with a second outer diameter coupled to the intermediate tubular section; wherein the first and second outer diameters are greater than the intermediate outer diameter. The outer surface of the first tubular section includes a first sealing member; and the outer surface of the second tubular section includes a second sealing member. The intermediate tubular section includes circumferentially spaced apart radial projections. The circumferentially spaced apart radial projections include a sealing member. The sealing member may be either an elastomer or a metal.

[0038] An expansion device for radially expanding a tubular member has been described that includes a first outer surface comprising a first angle of attack; a second outer surface coupled to the first outer surface comprising a second angle of attack; wherein the first angle of attack is greater than the second angle of attack; wherein the first angle of attack ranges from about 8 to 20 degrees; and wherein the second angle of attack ranges from about 4 to 15 degrees; and a rear end coupled to the second outer surface.

[0039] An expansion device for radially expanding a tubular member has been described that includes a first outer surface comprising a first angle of attack; a second outer surface coupled to the first outer surface comprising a second angle of attack; wherein the first angle of attack is greater than the second angle of attack; and wherein the angle of attack of the outer surfaces is defined by a parabolic equation.

[0040] A method of fabricating an expandable tubular member has been described that includes providing a tubular member that includes a first end, a second end, and an intermediate portion; upsetting the first end and the second end of the tubular member; radially expanding the first end and the second end of the tubular member; forming threaded connections on the first and second radially expanded ends of the tubular member; relieving stress in the first and second radially expanded ends of the tubular member; applying a first protective member to the outside diameter of the first end of the tubular member; applying a second protective member to the outside diameter of the second end of the tubular member; and applying a sealing member to the outside diameter of the intermediate portion of the tubular member; wherein the sealing member may be either an elastomer or a metal.

[0041] A method of fabricating an expandable tubular member has been described that includes providing a tubular member that includes a first end, a second end, and an intermediate portion; upsetting the first end and the second end of the tubular member; radially expanding the first end and the second end of the tubular member; forming threaded connections on the first and second radially expanded ends of the tubular member; relieving stress in the first and second radially expanded ends of the tubular member; applying a first protective member to the outside diameter of the first end of the tubular member; applying a second protective member to the outside diameter of the second end of the tubular member; forming circumferentially spaced apart radial projections on the intermediate tubular section; and applying a sealing member to the exterior of the projections; wherein the sealing member may be either an elastomer or a metal.

[0042] A method of coupling a tubular member to an existing tubular member in a borehole located in a subterranean formation has been described that includes installing a tubular liner and an expansion device in the borehole; overlapping the tubular liner with an existing tubular member; injecting fluidic material into the borehole; pressurizing a portion of an interior region of the tubular liner; radially expanding at least a portion of the liner in the borehole by extruding at least a portion of the liner off of the expansion device; wherein the tubular member includes a first tubular section with a first outer diameter; an intermediate tubular section with an intermediate outer diameter coupled to the first tubular section; and a second tubular section with a second outer diameter coupled to the intermediate tubular section; wherein the first and second outer diameters are greater than the intermediate outer diameter. The outer surface of the first tubular section includes a first sealing member; and the outer surface of the second tubular section includes a second sealing member. The outer surface of the intermediate tubular section also includes a sealing member. The sealing member may be either an elastomer, a metal, or a metal positioned between two elastomers.

[0043] A method of coupling a tubular member to an existing tubular member in a borehole located in a subterranean formation has been described that includes installing a tubular liner and an expansion device in the borehole; overlapping the tubular liner with an existing tubular member; injecting fluidic material into the borehole; pressurizing

a portion of an interior region of the tubular liner; radially expanding at least a portion of the liner in the borehole by extruding at least a portion of the liner off of the expansion device; wherein the tubular member includes a first tubular section with a first outer diameter; an intermediate tubular section with an intermediate outer diameter coupled to the first tubular section; and a second tubular section with a second outer diameter coupled to the intermediate tubular section; wherein the first and second outer diameters are greater than the intermediate outer diameter. The outer surface of the first tubular section includes a first sealing member; and the outer surface of the second tubular section includes a second sealing member. The intermediate tubular section includes circumferentially spaced apart radial projections. The circumferentially spaced apart radial projections include a sealing member. The sealing member may be either an elastomer or a metal.

[0044] A system of coupling a tubular member to an existing tubular member in a borehole located in a subterranean formation has been described that includes a means for installing a tubular liner and an expansion device in the borehole; a means for overlapping the tubular liner with an existing tubular member; a means for injecting fluidic material into the borehole; a means for pressurizing a portion of an interior region of the tubular liner; a means for radially expanding at least a portion of the liner in the borehole by extruding at least a portion of the liner off of the expansion device; wherein the tubular member includes a first tubular section with a first outer diameter; an intermediate tubular section with an intermediate outer diameter coupled to the first tubular section; and a second tubular section with a second outer diameter coupled to the intermediate tubular section; wherein the first and second outer diameters are greater than the intermediate outer diameter; and wherein the outer surface of the intermediate diameter section comprises a sealing member; the sealing member comprising an elastomer.

[0045] A system of coupling a tubular member to an existing tubular member in a borehole located in a subterranean formation has been described that includes a means for installing a tubular liner and an expansion device in the borehole; a means for overlapping the tubular liner with an existing tubular member; a means for injecting fluidic material into the borehole; a means for pressurizing a portion of an interior region

of the tubular liner; a means for radially expanding at least a portion of the liner in the borehole by extruding at least a portion of the liner off of the expansion device; wherein the tubular member includes a first tubular section with a first outer diameter; an intermediate tubular section with an intermediate outer diameter coupled to the first tubular section; and a second tubular section with a second outer diameter coupled to the intermediate tubular section with a second outer diameter; wherein the first and second outer diameters are greater than the intermediate outer diameter; wherein the intermediate tubular section comprises circumferentially spaced apart radial projections; and wherein the projections comprise a sealing member; and the sealing member comprises an elastomer.

[0046] Although illustrative embodiments of the invention have been shown and described, a wide range of modification, changes and substitution is contemplated in the foregoing disclosure. In some instances, some features of the present invention may be employed without a corresponding use of the other features, and some steps of the present invention may be executed without a corresponding execution of other steps. Accordingly, all such modifications, changes and substitutions are intended to be included within the scope of this invention as defined in the following claims, and it is appropriate that the claims be construed broadly and in a manner consistent with the scope of the invention. In the claims, means-plus-function clauses are intended to cover the structures described herein as performing the recited function and not only structural equivalents, but also equivalent structures.

Claims

What is claimed is:

1. An expandable tubular member, comprising:
a first tubular section comprising a first outer diameter;
an intermediate tubular section comprising an intermediate outer diameter
coupled to the first tubular section; and
a second tubular section comprising a second outer diameter coupled to the
intermediate tubular section;
wherein the first and second outer diameters are greater than the intermediate
outer diameter; and
wherein:
an outer surface of the first tubular section comprises a first sealing
member;
an outer surface of the intermediate tubular section comprises a sealing
member; or
the intermediate tubular section comprises circumferentially spaced apart
radial projections.
2. The expandable tubular member according to claim 1, wherein the outer surface
of the first tubular section comprises the first sealing member; and wherein an
outer surface of the second tubular section comprises a second sealing member.
3. The expandable tubular member according to claim 2, wherein the first sealing
member comprises an elastomer; and wherein the second sealing member
comprises an elastomer.
4. The expandable tubular member according to claim 2, wherein the first sealing
member comprises a metal; and wherein the second sealing member comprises
a metal.

5. The expandable tubular member according to claim 1, wherein the outer surface of the intermediate tubular section comprises the sealing member.
6. The expandable tubular member according to claim 5, wherein the sealing member comprises an elastomer.
7. The expandable tubular member according to claim 5, wherein the sealing member comprises a metal.
8. The expandable tubular member according to claim 5, wherein the sealing member comprises an elastomer bordered on its upper and lower edges by a metal ring.
9. The expandable tubular member according to claim 5, wherein the sealing member comprises a metal positioned between two elastomers.
10. The expandable tubular member according to claim 1, wherein the intermediate tubular section comprises the circumferentially spaced apart radial projections.
11. The expandable tubular member according to claim 10, wherein the radial projections comprise a sealing member.
12. The expandable tubular member according to claim 11, wherein the sealing member comprises an elastomer.
13. The expandable tubular member according to claim 11, wherein the sealing member comprises a metal.
14. An apparatus, comprising:

a tubular member formed by the process of radially expanding an unexpanded tubular member into contact with an approximately cylindrical passage using an expansion device, the unexpanded tubular member comprising:

- a first tubular section comprising a first outer diameter;
- an intermediate tubular section comprising an intermediate outer diameter coupled to the first tubular section; and
- a second tubular section comprising a second outer diameter coupled to the intermediate tubular section;

wherein the first and second outer diameters are greater than the intermediate outer diameter; and

wherein:

- an outer surface of the first tubular section comprises a first sealing member;
- an outer surface of the intermediate tubular section comprises a sealing member; or
- the intermediate tubular section comprises circumferentially spaced apart radial projections.

15. An expansion device for radially expanding a tubular member comprising:
 - a first outer surface comprising a first angle of attack;
 - a second outer surface coupled to the first outer surface comprising a second angle of attack;wherein the first angle of attack is greater than the second angle of attack.
16. The expansion device of claim 15, further comprising:
 - a rear end coupled to the second outer surface.
17. The expansion device of claim 15, wherein the first angle of attack ranges from about 8 to 20 degrees; and wherein the second angle of attack ranges from about 4 to 15 degrees.

18. The expansion device of claim 15, further comprising one or more intermediate outer surfaces coupled between the first and second outer surfaces.
19. The expansion device of claim 18, wherein the angle of attack of the intermediate outer surfaces continually decreases from the first outer surface to the second outer surface.
20. The expansion device of claim 18, wherein the angle of attack of the intermediate outer surfaces decreases in steps from the first outer surface to the second outer surface.
21. The expansion device of claim 18, wherein the angle of attack of the outer surfaces is defined by a parabolic equation.
22. The apparatus according to claim 14, wherein the outer surface of the first tubular section comprises the first sealing member; and wherein an outer surface of the second tubular section comprises a second sealing member.
23. The apparatus according to claim 22, wherein the first sealing member comprises an elastomer; and wherein the second sealing member comprises an elastomer.
24. The apparatus according to claim 22, wherein the first sealing member comprises a metal; and wherein the second sealing member comprises a metal.
25. The apparatus according to claim 14, wherein the outer surface of the intermediate tubular section comprises the sealing member.
26. The apparatus according to claim 25, wherein the sealing member comprises an elastomer.

27. The apparatus according to claim 25, wherein the sealing member comprises a metal.
28. The apparatus according to claim 25, wherein the sealing member comprises an elastomer bordered on its upper and lower edges by a metal ring.
29. The apparatus according to claim 25, wherein the sealing member comprises a metal positioned between two elastomers.
30. The apparatus according to claim 14, wherein the intermediate tubular section comprises the circumferentially spaced apart radial projections.
31. The apparatus according to claim 30, wherein the radial projections comprise a sealing member.
32. The apparatus according to claim 31, wherein the sealing member comprises an elastomer.
33. The apparatus according to claim 31, wherein the sealing member comprises a metal.
34. A method of fabricating an expandable tubular member, comprising:
providing a tubular member comprising a first end, a second end, and an intermediate portion;
radially expanding the first end and the second end of the tubular member; and
at least one of:
 applying a sealing member to the outside diameter of the intermediate portion of the tubular member; and
 forming circumferentially spaced apart radial projections on the intermediate portion of the tubular member.

- 35. The method of claim 34, further comprising:
prior to radially expanding, upsetting the first end and the second end of the
tubular member.
- 36. The method of claim 34, further comprising:
forming threaded connections on the first and second radially expanded ends of
the tubular member.
- 37. The method of claim 34, further comprising:
relieving stress in the first and second radially expanded ends of the tubular
member.
- 38. The method of claim 34, further comprising:
applying a first protective member to the outside diameter of the first end of the
tubular member; and
applying a second protective member to the outside diameter of the second end
of the tubular member.
- 39. The method of claim 34, wherein the method comprises applying the sealing
member to the outside diameter of the intermediate portion of the tubular
member.
- 40. The method of claim 39, wherein the sealing member comprises an elastomer.
- 41. The method of claim 39, wherein the sealing member comprises a metal.
- 42. The method of claim 34, wherein the method comprises forming the
circumferentially spaced apart radial projections on the intermediate portion of
the tubular member.
- 43. The method of claim 42, further comprising:

applying a sealing member to the exterior of the projections.

44. The method of claim 43, wherein the sealing member comprises an elastomer.
45. The method of claim 43, wherein the sealing member comprises a metal.
46. A method of coupling a tubular member to an existing tubular member in a borehole located in a subterranean formation comprising:
 - installing a tubular liner and an expansion device in the borehole;
 - overlapping the tubular liner with an existing tubular member;
 - injecting fluidic material into the borehole;
 - pressurizing a portion of an interior region of the tubular liner;
 - radially expanding at least a portion of the liner in the borehole by
 - extruding at least a portion of the liner off of the expansion device;
 - wherein the tubular member comprises:
 - a first tubular section comprising a first outer diameter;
 - an intermediate tubular section coupled to the first tubular section
 - comprising an intermediate outer diameter; and
 - a second tubular section comprising a second outer diameter coupled to the intermediate tubular section comprising a second outer diameter;
 - wherein the first and second outer diameters are greater than the intermediate outer diameter.
47. The method according to claim 46, wherein an outer surface of the first tubular section comprises a first sealing member; and wherein an outer surface of the second tubular section comprises a second sealing member.
48. The method according to claim 47, wherein the first sealing member comprises an elastomer; and wherein the second sealing member comprises an elastomer.

49. The method according to claim 47, wherein the first sealing member comprises a metal; and wherein the second sealing member comprises a metal.
50. The method according to claim 47, wherein the first sealing member comprises a metal; and wherein the second sealing member comprises a metal.
51. The method according to claim 46, wherein an outer surface of the intermediate tubular section comprises a sealing member.
52. The method according to claim 51, wherein the sealing member comprises an elastomer.
53. The method according to claim 51, wherein the sealing member comprises a metal.
54. The method according to claim 51, wherein the sealing member comprises an elastomer bordered on its upper and lower edges by a metal ring.
55. The method according to claim 51, wherein the sealing member comprises a metal positioned between two elastomers.
56. The method according to claim 46, wherein the intermediate tubular section comprises circumferentially spaced apart radial projections.
57. The method according to claim 56, wherein the radial projections comprise a sealing member.
58. The method according to claim 57, wherein the sealing member comprises an elastomer.

59. The method according to claim 57, wherein the sealing member comprises a metal.



Application No: GB0620188.3

Examiner: Alan Jones

Claims searched: 1-14

Date of search: 15 January 2007

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1, 5, 7 & 14	GB2404677 A (WEATHERFORD/LAMB) See e.g. fig 1, abstract, tubular 10, intermediate portion 14 & metal sealing member 16
X	1, 5, 6 & 14	GB2396635 A (WEATHERFORD/LAMB) See e.g. fig 4, tubular 105, elastomer sealing elements 140, 160
X	1, 5 & 14	WO02/28560 A2 (OBI CORP.) See e.g. fig 1, intermediate section 18, scaling member 20, 22
X	1, 5, 6 & 14	WO01/18353 A1 (E2 TECH) See e.g. fig 3, first and second sections 16, 18, intermediate section 20, elastomer sealing member 22 & p19 lines 21-24
X	1-4	WO00/66877 A1 (THRU-TUBING TECH.) See e.g. fig 5, tubular 2, first and second sections 16, 40, metal sealing members 18, 46, elastomer seals 20, 48
X,Y	X: 1, Y: 10	US2003/0227170 A1 (HASHEM) See e.g. fig 2, first tubular section 40 sealing member 41 & paragraphs [0007]-[0008]
Y	10	WO02/095178 A1 (DRIL-QUIP) See e.g. fig 1A, circumferentially spaced radial projections 24, 25 and p1 lines 6-10

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^X:

E1F

Worldwide search of patent documents classified in the following areas of the IPC

E21B



For information

The following online and other databases have been used in the preparation of this search report

Online: WPI, EPODOC